Burnley Tunnel Fire - The Arup View

The fire which followed a tragic road accident in the Burnley Tunnel in Melbourne on 23 March 2007 has attracted a good deal of media, community and industry attention. For fire safety professionals, particular interest has focussed on the apparent success of the water deluge system in preventing fire spread and major tunnel damage.

This paper highlights the major design features of the tunnel, its fire protection measures and the sequence of events which led to the fire and its subsequent control.

The details in this paper are gleaned only from media reports and publicly available information. They are therefore speculative, and will only be confirmed once official investigations and the coronial enquiry are completed.

Tunnel details

The Burnley Tunnel forms part of the CityLink toll road system and is one of the pair of tunnels which carries traffic under the Yarra River and part of the city in Melbourne, Australia. The CityLink tunnels were opened in 2001.

The two tunnels, namely the Burnley Tunnel and the Domain Tunnel are both three lanes, but have different alignments, lengths, and depths below grade. They run in parallel only for part of their length as illustrated in Figure 1 below. Each tunnel has no breakdown lane or stopping bays.

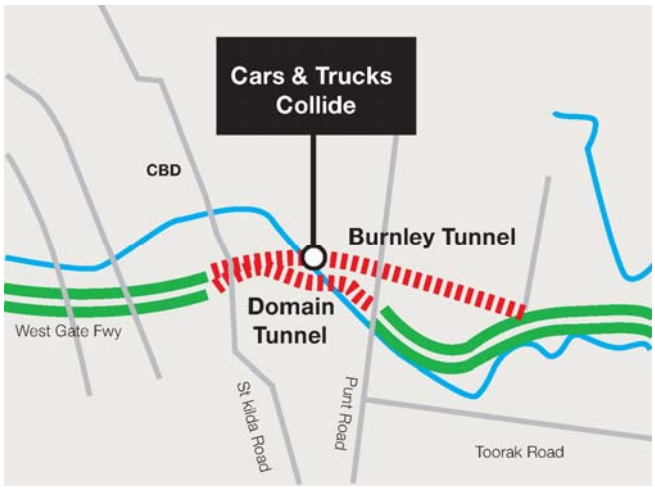

FIGURE 1. Tunnel Location

The Burnley Tunnel which takes traffic from west to east around the city has a length of approximately 3.4km, and at its deepest point is some 65m in below grade, as illustrated in Figure 2. The grades in the Burnley Tunnel are significant, with a 6.2 degree downhill slope starting at the entry and 5.2 degrees on the upgrade toward the exit portal.

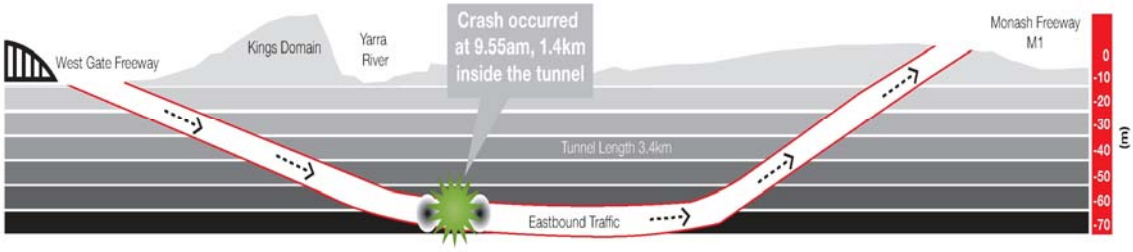

FIGURE 2. Longitudinal Tunnel Section

The tunnel cross section clear of equipment at roof level is approximately 4.9m high, with three lanes each 3.5m wide. This is illustrated in Figure 3.

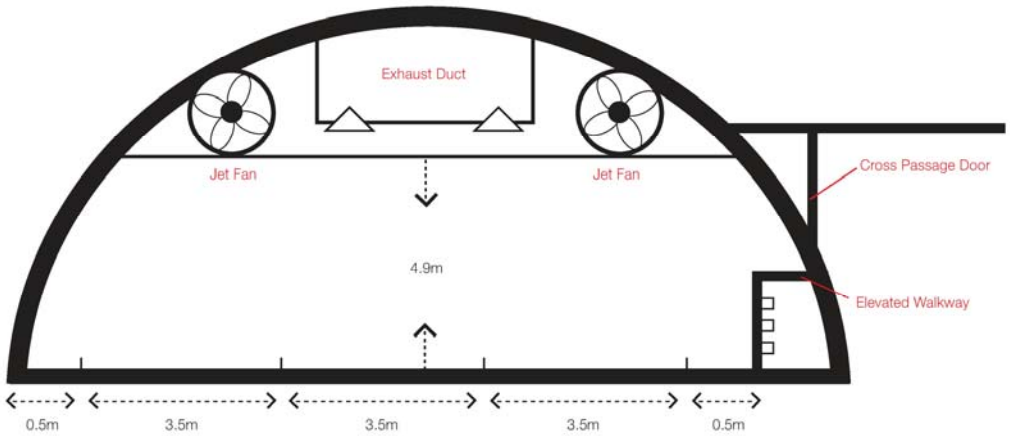

FIGURE 3. Tunnel Cross Section (not to scale)

The tunnel carries high traffic volumes with substantial numbers of freight vehicles along with cars and buses. Latest figures indicate usage of over 100,000 vehicles/day, of which 14,000 are trucks. The normal speed limit is 80km/hr, but in times of lane closure, minor accidents or maintenance periods, the speed limit is usually reduced to 60km/hr. During peak hours, traffic can be congested and travelling at less than the signed speed limits.

The tunnels, together with the associated toll road system, is managed by CityLink on behalf of the ultimate owner Transurban, who own and operate other toll road systems in Australia and the US.

Fire safety features

The Burnley and Domain Tunnels were considered to have the state-of-the-art fire protection when constructed. In part, this was due to studies conducted by the CityLink design team on the results of the Mont Blanc fire, and the design of the Harbour Tunnel in Sydney.

The key fire safety features include:-

- A water based deluge system, with 30m long zones, normally activated remotely from the control room
- A combination longitudinal and semi-transverse smoke control system, with a central duct at tunnel roof level with extract dampers at 80m intervals, plus sets of jet fans to control critical velocity. The duct extract is vented through an exhaust stack(s) at the end(s) of the tunnels.
- A linear heat detection system set at 68°C.
- Cross passages to the adjacent tunnel and exits to an emergency egress tunnel for part of the Burnley Tunnel. In addition, there are three safe havens and one lift to the surface.
- An elevated walkway about 750mm high and 750mm wide on the right hand side (inside) of the tunnel.
- "Fire boxes", consisting of hydrants, hose reels, and portable extinguishers about each 60m.
- A CCTV system, with cameras at 150m centres, with stopped vehicle alarm provisions.
- A radio 'break in' system with AM/FM rebroadcasting to transmit traffic control or emergency messages
- Overhead variable message signage at 120m intervals to indicate lane closure, and other emergency messages. Also speed limit signs
- Exit signs to cross passage/exit doors
- A public address/emergency warning system, and emergency telephones at 120m centres.
- DISPLAN communication points for emergency services direct communication to their control rooms.
- Emergency lighting systems
- An emergency incident management plan, which has been regularly well rehearsed by CityLink staff with the emergency services

The incident

The traffic accident which triggered the fire occurred at approximately 10am on Friday 23 March 2007, a little after the peak hour rush but at a time of relatively heavy traffic volumes. The accident occurred about 1.4km into the Burnley Tunnel at the end of a long downhill grade.

Media accounts suggest the following sequence of events:-

- A truck travelling through the tunnel suffered a tyre blow-out and pulled to a stop in the tunnel's left hand lane

- The truck stopped was immediately detected by a CCTV camera linked to the CityLink's control room
- An alarm sounded in the control room, and tunnel signs told motorists that the left-hand lane was closed, the speed limit was reduced (presumably to 60km/hr), and an incident response truck was dispatched
- Within 2 minutes of the alarm being raised, the traffic accident occurred when cars stopped behind the broken down truck tried to merge right and change lanes to get past the stopped truck
- A second semi-trailer truck (HGV), apparently travelling in the centre lane, struck these two cars, throwing one between the tunnel wall and the stationery truck, and crushing one into the back of the stationary truck. A third car, hit by this second truck, was thrown into the right hand lane, and struck by a third truck.
- It appears at least one of the cars burst into flames, and people reported a number of "explosions" and a "fire ball", with flames reaching the tunnel roof. It is unclear whether the "explosions" were the noise of the impacts, tyres bursting, or petrol or LPG actually exploding.
- The resultant fire led to the deluge system being activated (presumably manually from the control room) and the smoke exhaust system being activated. Cars ahead of the accident, and subsequent fire, drove out of the tunnel. However, some 200 cars and 400 people were stopped by the accident and fire, and were instructed to leave their cars and evacuate.
- Some people walked back through the incident tunnel to the tunnel entrance. The remainder evacuated using the cross passages and exit stairs linked to the Domain Tunnel which was closed soon after the accident. Media reports indicate there was "no sign of panic or alarm".
- The tunnel entrances became staging points or assembly areas for persons evacuated, where they were given identifying wrist bands, provided with food and water, and given instructions by police and CityLink emergency personnel.
- The deluge system appeared to control the fire, and the fire brigade attended with 30 fire trucks and 84 fire fighters, as well as 10 special police crash investigators.
- The fire was finally extinguished at approximately 11am, 1 hour after the accident occurred.
- Disabled people were assisted in evacuation by able bodied people apparently quite successfully
- The final toll was three dead (all drivers of the cars involved), plus two persons with minor injuries taken to hospital
- All cars remaining in the tunnel were removed by 1:30am on the following day.
- The non-incident Domain Tunnel was re-opened to traffic at 2:30pm on that day, Friday 23 March 2007.
- The Burnley Tunnel was re-opened to full traffic operations at 10am on the following Tuesday, 27 March 2007, four days after the incident, following system testing and checks of essential fire protection measures.

Fire performance

It appears that the deaths and injuries were due to the traffic accident and not the subsequent fire.

The water deluge system, which was zoned with open deluge heads and not a closed head sprinkler system, seems to have operated as intended and prevented fire spread from the immediate incident area. It appears to have been activated manually from the control room. There was some relatively minor damage to electrical systems in the immediate vicinity of the fire, but these were reasonably easily repairable.

The tunnel linings and exhaust duct appeared not to be damaged and were cleaned prior to the tunnel re-opening. The asphalt road surface suffered some minor damage but was repaired within three days.

According to media reports, the total asset damage and repair bill has been estimated at AUD$1.5 million and loss of toll revenue at AUD$3.0 million. Some temporary reduction in daily toll revenues might be expected in the weeks following the incident.

The CCTV also appears to have worked satisfactorily to provide an alarm to the control room to allow control room staff to make appropriate emergency management decisions.

The smoke extraction system appears to have worked satisfactorily, although it is unclear how much smoke was extracted downstream of the fire by the duct system, and how much smoke continued down the tunnel. However, given only some 100m of the tunnel needed to be cleaned, and there were reports of substantial smoke flowing out of the exhaust stack from the duct system, it indicates that heavy smoke was probably confined to this area near the fire. It also appears that the jet fans and exhaust duct operated to prevent “back layering” and smoke travelling uphill towards the tunnel entrance in the direction of evacuation.

The radio interrupt system and the signage telling drivers and passengers to stop their vehicles, begin evacuation and walk back towards the tunnel entrance, seems to have been heeded. Reports by evacuating people and the emergency services all seem to indicate that the pre-planning, fire drills and other training contributed significantly to the success of the entire emergency management system. This is in the following quote by Metropolitan Ambulance Operations Manager, Paul Holman, who said at the scene, “If there are any positives out of such a tragedy, it is that the emergency response worked like clockwork today. It was an horrific scene, but more importantly, it was safe…we could have had many more people injured or hurt.”

Further investigations

Following the incident, attention has centred on traffic management issues and avoidance of future accidents.

CityLink incident data has indicated that in 2006, there were 412 tunnel incidents attended to by the CityLink emergency response team. These included:-

- 11 banned prohibited users (errant vehicles)

- 17 accidents involving cars or trucks (5 causing minor or serious injuries)

The key issues to improve traffic safety and reduce the likelihood and severity of accidents which are being discussed in the media are:-

- Reduction in the speed limit for trucks to 60km/hr
- Trucks restricted to the left hand lane, and limited to use of the middle lane for overtaking
- All trucks banned from the right hand lane
- Provision of an emergency lane or breakdown bays in the tunnel (an expensive option)

There has also been a call by Professor Arnold Dix, an Australian member of the Permanent International Association of Road Congresses (PIARC) for more education to be given to drivers, especially when travelling on downhill sections of tunnels, and maintaining safe distances from vehicles in front of them.

It is clear that these issues will be canvassed further in the forthcoming official incident investigations. They are also likely to be discussed at the next meeting of the recently formed committee developing a new Australian Standard for fire safety in tunnels.

Conclusion

- The Burnley Tunnel traffic accident and subsequent fire was a major incident, resulting in three deaths and considerable damage.
- It appears that all the fire safety systems worked as intended
- The emergency management and evacuation and response appear to have ensured the safety of all those not directly involved in the initial accident.
- Major questions are being asked about tunnel design and traffic management in relation to future accident prevention
- Overall, in fire safety terms, the provision of the water based deluge and smoke control systems appear to have contributed most significantly to life safety and minimisation of asset damage and operational interruption.

The Authors

This paper was prepared by Peter Johnson and David Barber of Arup Fire in Melbourne. Further details of the incident can be obtained from Arup via the Arup website, www.arup.com, or via email to peter.johnson@arup.com.au and david.barber@arup.com.au. Considerable further detail is available through the media and other websites included in the reference list below.

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City Link Melbourne

Burnley Tunnel Accident and Fire

Burnley Tunnel is a 3.4km single directional 3 lane tunnel located close to Melbourne's central business district.

An incident occurred in the tunnel just before 10am Friday 23 March 2007 involving a number of vehicles.

The incident began with a broken down truck in the left lane of the three lane tunnel. A truck in the left lane attempted to move into the middle lane to avoid the broken down vehicle and in doing so collided with a number of other vehicles and eventually this truck collided with the original broken down vehicle. Two explosions occurred during the incident resulting in an almost instantaneous fire of significant size. Three trucks and five light vehicles were involved in the incident.

Traffic incident management plans and fire incident management plan were implemented quickly.

The fire incident management plan included a number of aspects:

1. Smoke management via smoke extraction through a roof duct and via the ventilation stack.
2. Deluge operation via a zoned deluge system.
3. Occupant evacuation.

The ventilation system prevented smoke flowing upstream of the fire incident allowing an orderly evacuation of occupants behind the fire site.

The deluge system bought the fire under control and in combination with the ventilation system, allowed the emergency services to move in and manage the fire incident.

An evacuation plan was implemented and all occupants within the tunnel were told to evacuate. Messages were provided to occupants through the radio rebroadcast system and public address system within the tunnel. Variable message signs were also used to provide information to occupants. Exit signs and lights were turned on guiding occupants to the nearest exit point.

The evacuation was orderly and there was little or no delay by occupants once asked to evacuate.

Based on observations made, the fire safety systems and incident management plans were effective and minimised the impact of the fire.

There was minimal damage to the tunnel which was reopened on Tuesday 27 March 2007.

The Age 23/3/07

Tunnel cameras show fatal impact

Police say the final death toll from Friday's horrific crash is three people.
Photo: *David Caird*

Police have been viewing graphic footage from security cameras in the Burnley Tunnel following yesterday's horrific crash and fireball, which claimed three lives.

They have also identified, but so far not named, the three people killed in yesterday's fiery multi-vehicle crash in Melbourne's Burnley Tunnel.

They include:

- a 51 year-old man from Essendon who was driving a Toyota van;
- a 37 year-old man from Sandringham who was driving a Holden ute;
- a 34 year-old man from Sunbury driving a Mazda sedan.

All were sole occupants of their vehicles.

The accident involving five light vehicles and three trucks occurred when a broken down truck sparked a pile-up in the cross city tunnel just before 10am yesterday.

A fireball erupted, forcing 400 people to flee the tunnel, leaving 200 cars stranded and causing traffic gridlock.

Victoria Police assistant commissioner Noel Ashby today appealed for witnesses to come forward as their information would be crucial in piecing together how the tragedy occurred.

Mr Ashby said police are putting together a series of video images from the tunnel's security cameras to scientifically reconstruct the crash.

"(The footage) shows the vehicle broken down in the left hand lane and it then shows vehicles moving to avoid the truck concerned and it then shows a large impact and a large flash of flame," he said.

He said police were investigating at all options and could not rule out speed or charges being laid.

"The major collision people will focus very heavily over the coming months on all options, but we can say we will not rule in or out any particular issues at this stage.

"It is a matter for the coroner, it is a matter for the OPP (Office of Public Prosecutions) but we'll wait and see where the evidence takes us."

Mr Ashby said it was too early to talk about whether speeds in the tunnel should be reduced or whether there should be any design changes to make it safer.

He said the tunnel's emergency procedures worked well and that the crash could have been much worse.

"There's no endemic history of danger at all in the tunnel system but it's something we will look at," he said.

"This is an incident that highlights how dangerous the roads are generally and how we can never take roads for granted at any time. It also shows us how tragedy can creep up at the most unexpected time."

Tunnel unscathed

CityLink and Vic Road engineers say the tunnel survived the crash and devastating fireball relatively unscathed.

Engineers, who moved in to inspect the tunnel at 7.00am today to examine the crash site, say apart from scorched surfaces, and damage to overhead cabling, the tunnel was largely intact.

It was formally handed back to the toll operator at 1.30am today for the debris to be cleared.

"Their initial report was that the tunnel looks amazingly safe and secure," CityLink spokeswoman Jean Kerr-Walsh said.

"Clearly there is damage but the first assessment is (that) the structure of the tunnel does appear to be sound."

The damage was isolated to a 10-metre section of the 3.4km tunnel just over a kilometre from the western entrance.

Scorchmarks on the wall and roof, damaged overhead cabling, melted tarmac and four blown out lights were the only signs of the tragedy.

The tunnel will remain closed for at least another 24 hours pending further assessments and repairs. A decision on its reopening is expected tomorrow.

It is likely to be out of action for days not weeks, Ms Kerr-Walsh said.

"Were not going to be rushed into re-opening, we don't compromise on safety...and we will make sure that everything, every system that needs to be in place is not only repaired but is fully tested before we re-open."

CityLink also announced today that tolls would be waived for affected motorists yesterday.

A damage bill has yet to be calculated.

With one of the city's major thoroughfares out of action CityLink is losing $100,000 a day in toll revenue.

Adopt UK standards?

Melbourne should adopt the UK's example and restrict trucks in tunnels to one lane to avoid tragedies like the one in the Burnley Tunnel, an expert says.

Monash University Associate Professor in civil engineering, Raphael Grzebieta, told ABC radio further investigation was needed into how trucks commuted through the 3.4km tunnel, which bypasses the CBD and joins the West Gate Freeway with the Monash Freeway.

"Obviously there's a long downgrade as the vehicles are going in," Professor Grzebieta said.

"I'd like to see what is being done in the UK should be done here and that is restrict the trucks to the left hand lane, only allow them to pass in the middle lane and allow the smaller vehicles to go in the right lane or middle lane."

The professor said emergency procedures were well organised and had worked smoothly yesterday.

"What was the big relief was the evacuation and the emergency services kicking in and ventilation of the tunnel and all the procedures that the engineers and emergency people had put together has worked," he said.

"It's been very well organised. Obviously the people were told to leave the keys in their car and walk out of the tunnel immediately."

Crashes inevitable

But Professor Grzebieta said the risk of crashes in the CityLink tunnel was inevitable even though it was designed to minimise the risk as much as possible, including strictly enforcing 80kmh speed limits.

"The tunnel has been assessed for risk of crashes - you'll always get crashes no matter what speed limit you do set," he said.

"In this particular instance, the risk was assessed and that's the reason why they prevent vehicles with hazardous goods going down that tunnel, that would be a very bad situation if we had vehicle with hazardous material in there and so they prevent that."

Professor Grzebieta said adding emergency lanes to the tunnel would have increased its costs "horrifically".

"It's a matter of cost effectiveness of transporting traffic through a tunnel like that," he said.

"Quite frankly I think they've done the best they can in terms of risks."

AAP

The Age 24/3/07

'It was like a bomb went off'

THE toll from yesterday's horrific Burnley Tunnel crash and inferno could rise above the three people confirmed dead, authorities have warned.

Police are seeking surveillance footage of the accident, which began in the tunnel just before 10am. They said it was not yet known how many people had been travelling in the cars destroyed in the carnage.

The tunnel could remain closed until Monday as investigators examine the scene and engineers assess it for structural damage, police said.

Explosions rocked the tunnel, motorists told of a huge wall of flames and temperatures soared above 1000 degrees. Police Assistant Commissioner Noel Ashby said some of the crash vehicles had turned into "balls of molten metal". Investigators had still not identified the make of some of the cars.

"We're still at this stage trying to scope if there is even greater loss of life," he said. "It's catastrophic down the tunnel … It's a major, major incident that has occurred."

The crash began when a truck suffered a tyre blow-out and pulled into the tunnel's left-hand lane. The tunnel does not have an emergency lane.

Two cars caught behind the truck tried to merge right. They were struck from behind by a semi-trailer, throwing one against the wall and one into the back of the stationary truck.

A third car was hit from the side by the same semi-trailer, then struck by a third truck.

Gabrielle Martin, who is 30 weeks pregnant and was travelling with her two-year-old son Felix, was caught up in the accident but escaped unharmed.

"It was totally unexpected," she said. "The truck swerved in front of me, hitting the car on the opposite side from me and so it hit me, but it didn't hurt us.

"And he swerved in front and hit what looked like a truck in front and then it exploded."

Truck driver Chris Lloyd said he was driving along the inside lane of the tunnel when a truck appeared out of nowhere. "The next thing I saw was just chaos — flames hitting the roof and just absolute chaos."

Michael Vond, who was travelling as a passenger in another truck said: "We were sitting there and 'bang!' Maybe it was a gas cylinder or a gas tank. It was like a bomb went off."

About 400 people walked away from 200 vehicles in the tunnel. Two people were taken to hospital with minor injuries after the smash, which sent black smoke pouring from stacks above the tunnel and caused traffic gridlock.

Police had to stand back as 29 fire trucks and 84 firefighters wearing breathing apparatus fought the blaze.

A motorist trapped in the tunnel, barrister Anthony Southall, QC, said the rescue effort was inadequate for those first frightening minutes when motorists were trying to walk out of the 3.4-kilometre tunnel unaided.

"There were no CityLink staff to direct us. In fact, there was a disabled lady in the car behind us and she needed some assistance."

The tunnel, which passes under the Yarra River to bypass the CBD, joins West Gate Freeway with the Monash Freeway.

Melbourne's traffic was chaotic for hours, with the Domain tunnel also closed. As the major collision investigation unit examined the scene, the wreckage was cleared by heavy haulage equipment.

The Domain Tunnel did not reopen until 3pm.

Metropolitan Fire Brigade spokesman David Mann said the fire was brought under control at 11.14am and extinguished soon after.

Acting Chief Fire Officer Keith Adamson said last night he was hopeful the death toll would stop at three, "but we don't know how many people were in each car".

"So we're just hopeful there was only one in each car." Disaster victim-identification police are working to establish the final toll.

While Mr Ashby said the tunnel could remain shut until Monday, VicRoads and CityLink last night said it could open this afternoon.

CityLink spokeswoman Jean Ker Walsh said the initial accident had occurred very quickly, before a CityLink recovery vehicle could respond.

"We do know that immediately our lane closure system was activated. Regrettably, before an accident response team could get there, the incident occurred."

Mr Ashby last night told the ABC it was important to keep an open mind about the cause of the pile-up.

He urged motorists to put the tragedy into perspective. "The tunnel's been around a long time," he said.

"There are very strong practices to shut down a particular lane where necessary … it happened so instantaneously, emergency practices were just starting to occur when the second and third crashes occurred."

Premier Steve Bracks expressed his condolences to the family and friends of those killed and thanked the emergency services for their effective response.

He said the accident had triggered CityLink's crisis emergency plan, which includes a fire extinguishing system, a separate evacuation tunnel, a smoke ventilation system and radio broadcasts.

The coroner will conduct a full investigation.

- With AAP, David Rood and Sarah-Jane Collins

The Age 23/3/07

Deluge's crucial aid role

THE Burnley Tunnel's "deluge system", which was triggered immediately yesterday, might have averted a disaster similar to the one that killed 42 people in France's Mont Blanc Tunnel in 1999.

The fire in the 11-kilometre Mont Blanc Tunnel was also caused by a truck crash, but the severity of the blaze was blamed on safety blunders and procedural neglect.

A CityLink engineer and members of the Melbourne Metropolitan Fire and Emergency Services Board flew to Mont Blanc after the fire to investigate ways to improve safety in the Burnley and Domain tunnels.

The CityLink tunnels were built with several emergency systems. Arnold Dix, an adjunct professor of engineering and Australian delegate to the World Road Authority on Fire and Life Safety, road tunnels, says the deluge system was crucial to containing the impact of the accident.

The truck that stopped inside the tunnel yesterday was immediately detected by a camera linked to CityLink's control room.

An alarm sounded in the control room, and signs inside the tunnel told motorists that the left-hand lane was closed. The speed limit was automatically lowered, and an incident response unit sent. But within two minutes of the alarm being raised, the collision occurred. After several explosions and a fire, sensors in the tunnel activated a water spray. Water is piped into the tunnel and is released at once, or section by section. Smoke extractors were also activated.

Several people who were evacuated said there were no signs of panic or alarm.

Some walked back through the length of the tunnel, while others used passages and staircases that linked to the Domain Tunnel, which was closed just after the incident.

"In modern road tunnels there are a range of special features," Professor Dix said. "Burnley has some even more advanced features. It's like a jumbo jet turned inside out. You drive through one and you think it's just a big hole in the ground, but actually what's happened here in Melbourne is one of the events that these tunnels are designed to manage."

Emergency services chiefs yesterday praised the quick responses. CityLink regularly does emergency drills to prepare for serious incidents.

Professor Dix was fairly confident that the tunnel's safety features would probably prevent major structural damage.

"It's quite true that in a fire in a tunnel it can burn quite hot, but the tunnels are built to control that and, in fact, that's what distinguishes Australian tunnels from everyone else in the world."

The Age 27/3/07

Burnley tunnel reopens

Reko Rennie
March 27, 2007 - 10:41AM

Traffic is now moving through the Burnley Tunnel this morning after its reopening following Friday's fatal crash that claimed three lives.

But there was a mystery delay as the 10am deadline passed, with cars and trucks queued to the end of Power Street in Southbank as CityLink staff removed signs and barriers.

Vehicles began driving through the tunnel about 10 minutes later.

CityLink has turned on signs displaying the tunnel speed of 80kmh and turned off the electronic 'tunnel closed' sign at the entrance.

Trucks dominated each lane, with semis outnumbering cars.

Standing at the exit, few vehicles could be seen coming out of the tunnel.

Traffic is moving slowly in the opposite direction, in the Domain Tunnel.

The Age 27/3/07

Tunnel vision

The intimidation fades whenthe vehicle emerges into daylight as the tunnel opens into Richmond andtraffi c follows the bends of the YarraRiver.
Photo: *Michael Clayton-Jones*

Stephen Moynihan
March 27, 2007

EVERY motorist has felt the sense of claustrophobia.

Boxed in by three semi-trailers while submerged under Melbourne in the Burnley Tunnel. It's not helped by the reverberations of loud diesel engines echoing off the tunnel's walls. It's enough to turn knuckles white. The intimidation fades when the vehicle emerges into daylight as the tunnel opens into Richmond and traffic follows the bends of the Yarra River.

After Friday's horrific accident, focus has now switched to how safe Melbourne's CityLink tunnels are.

The accident has sparked calls for lower speed limits for trucks, car-only lanes and the introduction of emergency lanes. It has also led to a flood of road users sharing stories on talk-back radio of near misses underground.

Today at 10am, traffic is expected to return to the Burnley Tunnel. It will operate in exactly the same way as it did on Thursday. Does anything need to change?

CityLink has said the tunnel speeds will remain the same, and the freight and road groups say limiting truck speeds will cause traffic chaos and reduce traffic flow.

While one expert has described the CityLink tunnels as among the best and safest in the world, another academic has joined the chorus of those wanting the speed limit lowered.

Monash University's associate professor Raphael Grzebieta - who is a past president of the Australian College of Road Safety - says trucks should be restricted to 60km/h when they travel through the CityLink tunnels. He also believes trucks should be kept to one lane and be allowed to use the middle lane to overtake. The right-hand lane would be kept clear for cars.'

(Some) truck drivers have said they have trouble controlling their vehicles when going down into the tunnel,' Grzebieta says. 'If there's no restrictions on what speed they can do down the tunnel, then we can expect another crash like the one of Friday in the future.'

Lowering the speed limits for trucks would not eliminate crashes but substantially reduce the risk, he says.

Friday was the first fatal traffic incident underground since CityLink was opened seven years ago. Every day, more than 140,000 vehicles use the West Gate, CityLink and Monash Freeway corridor. It's the heart of Melbourne's cross-town network, a vital artery for commuters and the most valuable piece of road for Victoria's billion-dollar freight industry.

Victorian Transport Association chief executive Phil Lovel says the industry is reeling from Friday's accident.'

We're shattered and the industry is shattered because you have to ask how does that happen,' Lovel says.

For more than a decade, the VTA - which is funded by more than 700 freight and logistics companies - has lobbied Government and the road industry to improve safety for truck drivers and motorists.

It works with trucking companies and vehicle manufacturers to educate the industry about new technology.

Better braking systems, stability control and awareness of driver fatigue.

The sad fact is that accidents do happen. The Victorian road toll since 1989 has shown a steady decrease in the number of fatalities from crashes in which heavy vehicles have been involved with 124 deaths in 1989 and 62 deaths in 2005.

Lovel says an education campaign must be launched to educate all drivers on the best ways for cars and trucks to share roads safely. Bans on trucks travelling in the right-hand lane should also be introduced. Last year, plans for a truck-only lane trial were dropped because of the lack of distance between on and off-ramps along the Monash Freeway. He's hopeful that once the $1 billion project to upgrade the West Gate-CityLink- Monash corridor is completed, truckonly lanes can be trialled.

But this massive expansion of the corridor also means more road space.

Emergency lanes along some sections of the road will be converted for traffic.

An Australian who is a leading world expert on tunnel and road safety, Professor Arnold Dix, says emergency lanes can create just as many risks for motorists. He believes they can be misused by motorists who travel on them as a rat run to avoid slower traffic. Dix is an engineering professor, barrister and a specialist infrastructure risk adviser and investigative counsel.

He has advised contractors on tunnel safety for projects in Ireland, Europe and Japan. He says international experience shows that tunnels built with emergency lanes are soon converted for traffic when capacity is reached.

Dix says CityLink's safety measures are among the world's best with the tunnels' smoke-extraction system able to clear tunnels of smoke and fumes and its controlled waterdeluge system able to contain fires.

The tunnels are covered by cameras, which identify broken-down or stuck vehicles. CityLink's control room then dispatches an emergency recovery vehicle.

Emergency services have also praised the effectiveness of the tunnel's smoke-extraction and water-deluge systems, which not only contained the fire but made the air breathable for drivers to get out and paramedics to enter. Those who were killed on Friday died because of the collision, not from smoke inhalation or other dangers.

Many of the 42 people who died in the Mont Blanc tunnel disaster in 1999 did so from smoke. Many tried to outrun the plumes of toxic air while a substandard ventilation system actually kept pumping fumes into the tunnel limiting

visibility for firefighters and providing a smokescreen for motorists trying to find refuge shelters inside the 11-kilometre tunnel.

Melbourne's newest tunnels are the twin 1.6 kilometre tubes that dive under the Mullum Mullum Valley as part of the $2.5 billion dollar EastLink toll road. It too has a water-deluge system and will be continually monitored by cameras. An EastLink spokesman said the company would look at lessons learned from the Burnley accident and review its safety features on the advice of police, VicRoads and the coronial inquiry.

But for all safety precautions, people will always drive over the speed limit.

Speed cameras inside the CityLink tunnels are believed to be one of the state's biggest cash-cows, fining drivers who try to speed past trucks that climb the steep gradient when travelling east through the Burnley Tunnel.

While advocating a reduction in speed limits, Raphael Grzebieta also says the CityLink tunnels are 'reasonably safe'.'

It's just the people who are in there driving at a speed which they can't stop their vehicles,' he says. 'Everyone has this notion that it's a tunnel but it's no different to the rest of the freeway and it just so happens that the incident occurred inside the tunnel.'

He believes because the accident occurred in the tunnel, the explosions and subsequent fire was better contained. He says drivers cause accidents not roads.'

The issue is whether you can slow the truck down quickly enough. If one of the trucks has pulled over and slowed, then why did the other trucks not slow down?' While Victoria is miles ahead of other state's in combating the road toll and the dangerous affects of speed, Australia lags behind Europe in the development and use of safer trucks.

European legislation exists for requirements on the braking systems of trucks and also on which lanes they can travel.'

People coming from Europe to Australia cannot believe what goes on in regard to trucks and the freedom they have manoeuvring around on our roads. Segregation is the key,' Grzebieta says.

Lovel feels a middle ground has to be reached. Ban trucks from the right-hand lane to increase traffic flow but at the same time allow the freight industry to grow.

The VTA is actively educating the trucking industry to upgrade its fleet to safer and more efficient vehicles.

Newer trucks have lower greenhouse emissions and are developed with stronger braking capabilities.

As cities across the globe struggle to ease congestion on their roads, more tunnels will be built. Many of them are not equipped with emergency lanes but instead use traffic technology to monitor and control the flow of traffic through confined spaces.

In Switzerland, trucks and cars travel at the same speed and only one tunnel has emergency lanes. There are no restrictions on what type of trucks can use the tunnels. The St Gotthard Tunnel in Switzerland is the secondlongest road tunnel in the world and has a set speed limit of 80km/h.

In France, trucks are restricted to lower speeds in some tunnels while in others overtaking is prohibited.

The Victorian Government is in the middle of a $5 million study into a new tunnel linking the Eastern Freeway to Melbourne's west. While public transport advocates claim the deal for a billion-dollar tollway has all but been signed off, it remains to be seen if any lessons from Friday's accident will be learnt and acknowledged to ensure a similar tragedy does not occur again.