IN THE CORONERS COURT
OF VICTORIA
AT MELBOURNE

Court Reference: COR 2015 6555

FINDING INTO DEATH WITH INQUEST

Form 37 Rule 60(1)

Section 67 of the Coroners Act 2008

Deceased:	Anthony Francis CARNEVALE
Delivered on:	30 September 2018
Delivered at:	Coroners Court of Victoria, 65 Kavanagh Street, Southbank
Hearing date:	Inquest heard 22 March 2017 Round table conference 29 May 2017
Findings of:	Coroner Paresa Antoniadis SPANOS
Counsel assisting the Coroner:	Leading Senior Constable Duncan McKENZIE from the Police Coronial Support Unit
Representation	Mr A. HANDS appeared on behalf of the deceased's mother Ms Karen HILLS Mr Dimitri ZEMA appeared on behalf of Mr Dominic ZEMA

Mr P. PANNO appeared on behalf of RIX NOMINEES, an AVIS franchisee

Catchwords: LPG gas cylinders; transportation in rear truck compartment/confined space; gas leak; lean fuel-air mix; BLEVE boiling liquid evaporating vapour explosion; accidental death of driver; head injury.

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I, PARESA ANTONIADIS SPANOS, Coroner,
having investigated the death of ANTHONY FRANCIS CARNEVALE

and having held an inquest in relation to this death at Melbourne on 22 March 2017:

find that the identity of the deceased was ANTHONY FRANCIS CARNEVALE

born on 26 March 1991

and that the death occurred on 29 December 2015

at or near the intersection of Gordon and Barkly Streets, Footscray, Victoria 3121

from:

I (a) HEAD INJURY

in the following circumstances:

INTRODUCTION[1]

1. Mr Carnevale was a twenty four year old man who had been in a relationship with Domenic Zema for about 12 months, during the last six months of which they had lived together. Mr Carnevale had no known significant medical history and smoked about one packet of cigarettes a day.

2. In late 2015, Mr Carnevale and Mr Zema had been living between two apartments ultimately deciding to move into an apartment together. They had household items in storage across several locations and were in the process of moving these items over the Christmas 2015 period.

3. In order to assist with this process, the couple had hired an orange coloured 2015 Holden sedan registered number 1GH 1GD [the sedan] and a white coloured 2009 Isuzu three tonne truck registered number ZZY 677 [the truck].[2]

EXPLOSION ON 29 DECEMBER 2015

[1] This section is a summary of background and personal circumstances and uncontentious circumstances that provide a context for those circumstances that were contentious and will be discussed in some detail below.
[2] The sedan was hired from Hertz and the truck from Avis. It appears that both vehicles were hired by Mr Zema as Mr Carnevale did not meet the minimum 25 year old age limit but both of them drove the vehicles at various times.

4. Overnight on 28-29 December 2015, the Isuzu truck, loaded with miscellaneous personal and household items, was parked near Sims Supermarket, situated at the corner of Warleigh Road and Barkly Street, Footscray. Mr Carnevale left home in the sedan at about 10.15am and made his way to the truck. At about 11.30am on 29 December 2015, Mr Carnevale and Mr Zema spoke on the telephone for about seven minutes. During this call, Mr Carnevale said he had just arrived at the truck.

5. Shortly thereafter, Mr Carnevale left the location in the truck, driving east along Barkly Street, Footscray, and at about 11.53am entered the intersection of Barkly and Gordon Streets. As he drove through the intersection continuing east, the rear storage compartment of the van exploded, the force of the blast forcing the roof, walls and rear doors of the storage compartment apart and the rear cabin wall forward, crushing Mr Carnevale against the steering wheel.

6. After the blast, the truck continued in an easterly direction on Barkly Street colliding into a power pole, then the low brick fence at the front of residential premises and finally the dividing fence between the residential and commercial premises at 382 Barkly Street.

7. The explosion was witness by many people, including Russell Bannister who lived nearby. Mr Bannister was one of the first on the scene and ran to the truck. He saw Mr Carnevale seated in the driver's seat but was unable to elicit a response from him. Mr Bannister observed no signs on life in Mr Carnevale and ran back into his home to call 000. There were a total of 15 separate calls made to 000 in respect of the incident.

8. Emergency responders started arriving at the scene from about 11.55am. They included police and members of the Metropolitan Fire Brigade [MFB] who confirmed that Mr Carnevale was deceased.[3]

9. The police members established a crime scene to ensure the preservation of evidence while the MFB members removed members of the public from the immediate area until they could ensure the area was safe.[4]

INVESTIGATION AND SOURCES OF EVIDENCE

10. This finding is based on the totality of the material the product of the coronial investigation of the death of Mr Carnevale. That is, the brief of evidence compiled by Detective Senior Constable Jeremy Hart from the Maribyrnong Crime Investigation Unit of Victoria Police and material obtained by my assistant Leading Senior Constable Duncan McKenzie from the

[3] Two other members of the public were injured by the blast but their injuries were not life threatening.
[4] Exhibit F, statement of DSC Jeremy William Hart dated 23 May 2016 at page 91 of the coronial brief.

Police Coronial Support Unit, the statements, reports and testimony of those witnesses who testified at inquest and any documents tendered through them.

11. All of this material, together with the inquest transcript, will remain on the coronial file.[5] In writing this finding, I do not purport to summarise all the material and evidence, but will refer to it only in such detail as is warranted by its forensic significance and in the interests of narrative clarity.

PURPOSE OF A CORONIAL INVESTIGATION

12. The purpose of a coronial investigation of a *reportable death*[6] is to ascertain, if possible, the identity of the deceased person, the cause of death and the circumstances in which death occurred.[7] It is self-evident that the Mr Carnevale's death falls within the definition of a reportable death.

13. The *cause* of death refers to the *medical* cause of death, incorporating where possible the *mode* or *mechanism* of death. For coronial purposes, the *circumstances* in which death occurred refers to the context or background and surrounding circumstances, but is confined to those circumstances sufficiently proximate and causally relevant to the death, and not all those circumstances which might form part of a narrative culminating in death.[8]

14. The broader purpose of any coronial investigation is to contribute to the reduction of the number of preventable deaths through the findings of the investigation and the making of recommendations by coroners, generally referred to as the *prevention* role.[9]

15. Coroners are empowered to report to the Attorney-General in relation to a death; to comment on any matter connected with the death they have investigated, including matters of public health or safety and the administration of justice; and to make recommendations to any Minister or public statutory authority on any matter connected with the death, including

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[5] From the commencement of the ***Coroners Act 2008*** (the Act), that is 1 November 2009, access to documents held by the Coroners Court of Victoria is governed by section 115 of the Act. Unless otherwise stipulated, all references to legislation that follow are to provisions of the Act.

[6] The term is exhaustively defined in section 4. Apart from a jurisdictional nexus with the State of Victoria (see section 4(1)), reportable death includes *"a death that appears to have been unexpected, unnatural of violent or to have resulted, directly or indirectly, from an accident or injury"* (see section 4(2)(a) of the Act).

[7] Section 67(1).

[8] This is the effect of the authorities – see for example *Harmsworth v The State Coroner* [1989] VR 989; *Clancy* v *West* (Unreported 17/08/1994, Supreme Court of Victoria, Harper J.)

[9] The 'prevention' role is now explicitly articulated in the Preamble and purposes of the Act, compared with the *Coroners Act 1985* where this role was generally accepted as 'implicit'.

public health or safety or the administration of justice.[10] These are effectively the vehicles by which the coroner's prevention role can be advanced.[11]

16. It is important to stress that coroners are not empowered to determine the civil or criminal liability arising from the investigation of a reportable death, and are specifically prohibited from including in a finding or comment any statement that a person is, or may be, guilty of an offence.[12]

FINDINGS AS TO UNCONTENTIOUS MATTERS

17. As Mr Carnevale suffered a fatal head injury and facial fractures with some disruption to the facial features, he was not suitable for visual identification and his identity was established by fingerprint analysis and comparison, as well as extensive circumstantial evidence. Mr Carnevale's identity was otherwise uncontentious, as were the date and place of his death.

18. I accordingly find, as a matter of formality, that Anthony Francis Carnevale, born on 26 March 1991, late of 17 Quinn Street, Deer Park, died at or near the intersection of Barkly and Gordon Streets, Footscray, Victoria, on 29 December 2015.

MEDICAL CAUSE OF DEATH

19. Senior forensic pathologist and Associate Professor David Ranson from the Victorian Institute of Forensic Medicine [VIFM] reviewed the circumstances of death as reported by police to the coroner, post-mortem CT scanning of the whole body undertaken at VIFM [PMCT] and performed an external examination of Mr Carnevale's body in the mortuary. Having done so, A/Prof Ranson advised that Mr Carnevale had sustained major cranial trauma and his death could reasonably be attributed to *head injury.*

20. However, he recommended an autopsy to exclude any contribution from underlying natural disease to the death and/or the motor vehicle collision thought to have preceded the explosion/blast at that early stage; to enable full documentation of the nature and extent of the traumatic injuries sustained by Mr Carnevale and to elucidate the circumstances in which death occurred, in particular the nature and/or direction of blast forces.

[10] See sections 72(1), 67(3) and 72(2) regarding reports, comments and recommendations respectively.
[11] See also sections 73(1) and 72(5) which requires publication of coronial findings, comments and recommendations and responses respectively; section 72(3) and (4) which oblige the recipient of a coronial recommendation to respond within three months, specifying a statement of action which has or will be taken in relation to the recommendation.
[12] Section 69(1). However, a coroner may include a statement relating to a notification to the Director of Public Prosecutions if they believe an indictable offence may have been committed in connection with the death. See sections 69(2) and 49(1).

21. I accordingly directed an autopsy and routine full toxicological analysis of post-mortem samples. However, Ms Hills, Mr Carnevale's mother, did not want an autopsy performed on her son's body and asked for a reconsideration of my decision to direct an autopsy.[13]

22. I then sought further advice as to the current state of the police investigation of the explosion and was advised that the working hypothesis was of an explosion in the rear compartment of the truck, rather than a motor vehicle collision and that the suspected ignition source in the front cabin, a cigarette lighter, had been excluded. Moreover, A/Prof Ranson advised that he would obtain specialist radiological opinion as to the PMCT which might potentially provide some elucidation as to the source or trajectory of the explosion.

23. In those circumstances, I revoked the autopsy direction and the coronial investigation proceeded without autopsy. However, I confirmed my direction for routine full toxicological analysis of post-mortem samples.

24. A/Prof Ranson performed an external examination in the mortuary and provided a written report of his findings.[14] Under the heading 'Signs of Recent Injury', A/Prof Ranson noted diffuse disruption of the integrity of the skull, particularly in the region of the left facial area and the skull towards the back of the head, a large laceration 15cm in maximum extent running obliquely over the posterior aspect of the left parietal and occipital regions, multiple facial abrasion and mottled bruising over the front of the face, a diffuse area of bruising/reddening over the upper part of the neck and the left shoulder and multiple areas of ulceration of the limbs.

25. He also advised that PMCT revealed multiple areas of injury to skeletal structures particularly in the region of the head with the fragmentation of the skull being most severe on the left side posteriorly.

26. According to A/Prof Ranson, the *"pattern of injuries to the body including the pattern of damage to the head would indicate a severe force was applied to the head with evidence of blunt force injury to the head occurring at the back of the head and at the front of the head particularly on the left side."*[15] He accordingly advised that it would be reasonable to attribute Mr Carnevale's death to *head injury.*

[13] Pursuant to section 26 of the Act, the deceased's Senior Next of Kin [SNOK] may ask a coroner to reconsider an autopsy direction and, in the event that the coroner confirms the autopsy direction, may appeal to the Supreme Court.
[14] A/Prof Ranson's eight page report is at pages 83 to 90 of the coronial brief, Exhibit H, and includes his formal qualifications and extensive experience as a forensic pathologist.
[15] Exhibit H, coronial brief, at page 88.

27. Routine full toxicological analysis of post-mortem samples detected methylamphetamine at a level of ~0.7mg/L, amphetamine at ~0.2mg/L,[16] codeine free at ~0.1mg/L,[17] diazepam and its metabolite nordiazepam[18] both at ~0.2mg/L and promethazine[19] at ~0.1mg/L but no alcohol and no other commonly encountered drugs or poisons. None of the drugs present were at excessive or life-threatening concentrations either alone or in combination.

28. Relevantly, no propane was detected and testing for carboxyhaemoglobin detected a saturation of less than 5% providing evidence that there was little if any fire involved in the incident and/or that Mr Carenvale died either instantaneously with the explosion or within moments of the explosion.

29. Based on A/Prof Ranson's report, I find that the medical cause of Mr Carnevale's death is head injury.

THE FOCUS OF THE CORONIAL INVESTIGAITON AND INQUEST

30. The focus of the coronial investigation of Mr Carnevale's death was on the cause of the explosion:

    a. Whether or not a motor vehicle collision had caused or preceded the explosion

    b. If not, then what caused the explosion, encompassing the contents of the truck's rear compartment and access to them; the three LPG gas cylinders and whether they were secure or possibly leaking gas; and the ignition source.

    c. Given the force of the explosion and the potential for an even greater loss of life had the explosion occurred elsewhere, the need for improved safety around the storage and transportation of LPG gas cylinders intended for domestic use

DID A COLLISION CAUSE OR PRECEDE THE EXPLOSION?

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[16] According to Exhibit D, the toxicologist's report, "amphetamines" is a collective noun describing central nervous system stimulants structurally related to dexamphetamine. One of these "methamphetamine" is often known as "speed" or "ice" and is a strong stimulant drug that acts like the neurotransmitter noradrenaline and the hormone adrenaline. Further that one of the main effects sought by amphetamine users is euphoria, the high experienced with the amphetamine rush in the body which may last for several hours and is associated with an elevation of mood and increased alertness, increased confidence and increased mental and physical strength. I note that police searching Mr Carnevale in the aftermath of the incident found a tissue containing a glass "ice" pipe in the front right pocket of the jeans he was wearing. See Exhibit F, statement of Detective Senior Constable Jeremy William Hart, the coronial investigator at page 93 of the coronial brief.

[17] See Exhibit D. Codeine is a narcotic analgesic related closely to morphine but having about one-tenth the activity of morphine as an analgesic. It is present in numerous proprietary medicines as tablets containing up to 30mg of codeine phosphate often in combination with other analgesics such as aspirin and paracetamol. Codeine can also occur as a small contaminant in heroin.

[18] See Exhibit D. Diazepam is a sedative/hypnotic drug of the benzodiazepine class.

[19] See Exhibit D. Promethazine is an antihistamine available as the hydrochloride salt in numerous over-the-counter preparations for the relief of allergies.

31. It is entirely understandable that there was an initial hypothesis that a "simple" motor vehicle collision had caused or at least preceded the explosion. Consequently, Detective Senior Constable Christopher Hayes from the Major Collision Investigation Unit of Victoria Police [MCIU] was advised on the incident at 1.30pm and attended the scene at 3.00pm. Having taken some aerial photographs of the scene as a whole he returned to the scene at 3.45pm to conduct a more detailed examination of the physical evidence.[20]

32. DSC Hayes examined the truck in its post-incident state. He noted that the truck's cabin was pushed forward in a manner not consistent with a standard frontal collision with the pole. In his experience this type of damage was only seen where improperly restrained loads crush the driver's cabin under severe braking or a frontal collision while transporting a massive load.

33. Also, the checker plate tray of the truck was distorted, the rear half having been bent down indicating significant downward force had been applied to the rear compartment.

34. By reference to a scrape mark and blue paint transfer at the scene, DSC Hayes was of the view that the rear door frame of the truck which had detached from the truck during the incident, created the scrape mark as the truck careened east along Barkly Street before it left the carriageway.[21]

35. DSC Hayes attended the inquest and was cross-examined about aspects of his evidence by way of clarification and extrapolation. There was no serious challenge to the hypothesis he formulated. That is, that the explosion was not caused by any motor vehicle collision in the usual sense, rather, that an explosion was the initiating cause of the incident that damaged the truck and led to the loss of control thereafter resulting in impact between the truck and the brick fence and finally the pole.

CAUSE OF THE EXPLOSION:

ACCESS TO & CONTENTS OF THE TRUCK'S REAR COMPARTMENT

36. Mr Carnevale had previously hired a storage unit from Kennards Self-Storage Maribyrnong where he stored miscellaneous personal and household items [the Maribyrnong storage unit]. As mentioned above, over the Christmas 2015 period, Mr Carnevale and Mr Zema were moving residential addresses. On 15 December 2015, Mr Zema hired the truck from Avis

[20] Exhibit C, statement of Detective Senior Constable Christopher Hayes dated 2 January 2016, at pages 73-76 of the coronial brief. Amongst his other qualifications, DSC Hayes had completed the Victoria Police Arson Investigation Course.

[21] Exhibit C. DSC Hayes' conclusion at page 75 of the coronial brief was that "an explosion occurred in the cargo area…while the vehicle was underway. The explosion occurred in the approximate area adjacent to the white dual-cab utility and the carwash business on the north-east corner of Barkly Street and Gordon Street. The truck then careened off the carriageway and onto the footpath, striking utility pole and then collided which [sic] a small brick wall where it was observed in its final resting position."

situated at Geelong Road, Brooklyn, for this purpose. Two days later they hired the sedan from Hertz through Mr Carnevale's insurance company as his car had been stolen recently.[22]

37. Also on 17 December 2015, they hired a storage unit from Kennards Self-Storage at 138 Salmon Street, Port Melbourne [the Port Melbourne storage unit]. This unit was hired on a monthly basis in Mr Zema's name with Mr Carnevale listed as an alternative contact also authorised to access the storage unit.

38. On about three occasions between 17 and 28 December 2015, Mr Zema loaded Mr Carnevale's possessions from the Maribyrnong storage unit to the truck in preparation for the move. He did this himself as Mr Carnevale suffered from an allergy to dust mites which was likely to flare up if he worked in a (dusty) confined space such as the storage unit.[23]

39. Mr Carnevale brought two padlocks to secure the rear doors of the truck. The padlock on the left door was locked with a key and Mr Carnevale and Mr Zema each had a key. The padlock on the right door had a combination lock and while both knew the combination, Mr Zema had trouble using it so he always left the right door closed and secured with the padlock. Each time he finished loading the truck, Mr Zema would lock the padlock on the rear left door.[24] When not in use and overnight, the truck was parked at several different locations.[25]

40. According to Mr Zema, the contents of the truck that he recalled loading were – 50 milk crates with assorted power tools, standard tools, clothes, a bathroom sink, a red electric guitar, a four burner barbeque, two bottles of gas, two pin boards, five shelving units, a door frame, ten random chandelier style light fittings and about 30 black storage containers.

41. Mr Zema testified that he was only ever aware of two gas bottles within the items Mr Carnevale had in storage. He recalled that two gas bottles were among the last items loaded by him into the truck. He placed them in the rear compartment of the truck near the rear opening doors. He lifted the metal bottles by their collar and made sure that they were turned off. Judging by their weight alone, he estimated that they were half full at the time.[26]

42. At inquest, when shown photos of the three LPG 8.5 kilogram gas cylinders or bottles taken at the scene, shortly after the explosion, he identified the "Swap 'N Go" cylinder as something that looked familiar to him, by reference to its red label, and the "Kwik Gas" cylinder as

[22] Exhibit A, statement of Dominic Zema dated 29 December 2015 at page 20 of the coronial brief.
[23] Exhibit A. Mr Zema's best recollection of the dates when he moved items out of the storage unit into the rear compartment of the truck were Sunday 20 December, Monday 21 December and an earlier occasion before Sunday 20 December which he could not recall. See also transcript page 14.
[24] Exhibit A at pages 17-18 of the coronial brief and transcript page 20.
[25] Exhibit A at page 19 of the coronial brief.
[26] Exhibit A at page 19 of the coronial brief and transcript pages 15-16.

possibly the second one he loaded. He could not say if the third cylinder, the unbranded one, was one of the cylinders loaded by him.[27]

43. There was some confusion in Mr Zema's evidence about the location where the truck was last parked by him on 21 December 2015. While in his statement he referred to it being parked in Summerhill Road, Footscray, just before the intersection of Barkly Street, at inquest he clarified that he did not know the Footscray area well and that while he was driving on this occasion, Mr Carnevale was navigating. He also conceded that he may have been mistaken in that it may have been on 20 December 2015 that he parked the truck in Summerhill Road.[28]

44. It was Mr Zema's evidence that the truck was not moved between 21 and 28 December 2015. During that week (or so) he would drive-by and check on the truck as he drove to work but did not get down and check on the locks.[29]

45. On 28 December, Mr Zema went to Kennards Flemington and, after ensuring the storage unit was large enough to accommodate everything, hired another storage unit in his name [the Flemington storage unit]. At inquest, he explained that this was 'around the corner from work' and a more convenient location than the Port Melbourne storage unit which they decided to cancel after the first month that they had paid for had expired.[30]

46. On 28 December 2015, Mr Carnevale and Mr Zema were both home at their Deer Park address and went to bed at about 11.00pm. As far as Mr Zema was aware, they were both asleep until about 10.00am when he woke to find Mr Carnevale in the driveway washing his (that is Mr Zema's) car as he would often do. Mr Zema left to do some shopping for his restaurant that was due to re-open that day and they arranged that Mr Carnevale would pick up the truck and meet Mr Zema at the Flemington storage unit at midday so they could unload the truck before Mr Zema was due at work at 2.30pm.

47. Unbeknownst to Mr Zema, and on the basis of data obtained by police from the GPS system on the sedan, Mr Carnevale left home in the sedan and attended the Port Melbourne storage unit arriving at 1.32 am on 29 December 2015 and leaving about one and one half hours later at 2.46am. CCTV footage from Kennards Port Melbourne shows Mr Carnevale with an

[27] Transcript pages 24-25. See also pages 244, 246 and 253 of the coronial brief for photos of the gas bottles and the evidence of DSC Hart as to Mr Zema'a initial vacillation about the number of gas bottles - between two and three – at transcript pages 91-93. Note that in Exhibit E, Mr Kelleher's statement, this battery is described as an Aussie Huanri brand.
[28] Exhibit A and transcript pages 16-17.
[29] Exhibit A at page 19 of the coronial brief and transcript page 17.
[30] Transcript page 18.

unidentified male during this time, apparently putting items into the storage unit rather them taking them out.[31]

48. The tracking data indicates that Mr Carnevale did not return to the truck which was parked in the Sims IGA Supermarket car park at the intersection of Warleigh Road and Barkly Street, Footscray, only a short distance west of the intersection of Summerhill Road and Barkly Street. The data also indicates that Mr Carnevale did not return home until 5.30am.

THE THREE LPG GAS CYLINDERS[32]

49. The liquid petroleum gas [LPG] cylinders were of the common variety intended for domestic use, generally used to run a gas burning barbeque. Typically, they contain a flammable mixture of propane and butane.[33] Two of the LPG cylinders bore labels indicating they could be swapped when empty at a local convenience store or hardware store. While there is some doubt about the provenance of the third cylinder based on Mr Zema's recollection, I will refer hereafter to three gas cylinders as there were clearly three found in the debris, relevant to the coronial investigation and subjected to forensic examination.

50. Although he was not asked to provide a statement for the coronial brief, Damien O'Toole, a Metropolitan Fire Brigade [MFB] member of more than 29 years' experience in fire investigation and a permanent member of the Fire Investigation Section for over three years, gave evidence at the inquest. He was one of the first MFB members at the scene and saw the three gas bottles in situ within the cordoned off area.

51. Prior to his arrival, other MFB members had attached stickers to the three gas cylinders found within the debris of the explosion, indicating they were damaged, but they did not tamper with the valves.[34]

52. Mr O'Toole inspected the first gas cylinder. He turned the valve about a quarter of a turn and found it was loose, in the open position. The second and third gas cylinders were also in a partly opened state. He could not hear or smell any gas emanating from the cylinders and

[31] Subsequent investigation indicates that the contents of the Port Melbourne storage unit were the same sort of general household items as had been removed from the Maribyrnong storage unit and placed in the truck by Mr Zema. See transcript page 96.
[32] These are referred to as "cylinders" or "bottles" in various statements and in the transcript but for consistency are referred to as cylinders hereafter.
[33] Transcript page 52.
[34] Transcript pages 46-47. Mr O'Toole relied on notes taken at the time. He identified the two MFB members who he interviewed and testified that they said they neither heard gas leaking, nor smelt gas, and they did not touch the valves.

turned the valves back about a quarter of a turn.[35] According to his evidence, it would take three complete turns of the valve, each of 360 degrees, to go from closed to fully open. The extent to which the cylinders were open was sufficient to enable any gas contents to escape or leak.[36] He did not believe that the valves could be opened due to movement during transportation, or as a result of the force of the explosion.[37]

53. In terms of the mechanism of the explosion, Mr O'Toole explained that if any propane or butane leaked from the gas cylinders, being heavier than normal air, he would expect the gas to pool and concentrate in the lower part of the truck's rear compartment. According to Mr O'Toole, the explosive limits of the resultant air fuel mixture would be between 2% and 9.6% and the explosion would be of the BLEVE variety - boiling liquid evaporating vapour explosion not necessarily associated with fire or heat.[38]

54. John Desmond Kelleher is a scientist working at the Victoria Police Forensic Services Centre [VPFSC], Macleod, whose main duties since 1988 involve the investigation of fire and explosion scenes.[39] Mr Kelleher attended the scene on Tuesday 29 December 2015 where he was briefed by MFB members including Mr O'Toole and was assisted by a forensic officer/photographer.

55. Mr Kelleher conducted a scene examination, including the full extent of the debris field and damage to the truck and provided a detailed description in his statement.[40] He noted among other things that the debris included three 8.5 kilogram LPG gas cylinders found on the northern side of Barkly Street some 20 metres past the intersection. Mr O'Toole briefed him as to the state of the gas cylinders advising that he had found them to be 'turned on but empty'.[41] At inquest, like Mr O'Toole, he also belied the proposition that movement during transport could have loosened or opened the valves.[42]

56. Mr Kelleher's inspection of the cylinders indicated that the valve of the Swap 'N Go cylinder was open approximately ½ turn, the Kwik Gas approximately ¾ turn and the third cylinder 1 ½ turns.[43] He found the cylinders to be in good condition, except for relatively minor damage

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[35] Transcript page 48.
[36] Transcript pages 48-50.
[37] Transcript pages 51 and 59.
[38] Transcript pages 60-64.
[39] Mr Kelleher's formal qualifications and experience appear at the beginning of Exhibit E, his statement dated 3 February 2016 at pages 77-82 of the coronial brief. I note his qualifications include a Bachelor Degree in Applied Science and that prior to commencing employment at VPFSC he was employed for five years in the Explosives Branch of the Department of Labour as a Chemist and Inspector of Explosives.
[40] Exhibit E, at pages 77-80 of the coronial brief.
[41] Transcript page 67.
[42] Transcript page 69, 83.
[43] For internal consistency, I have referred to this as the third/unbranded cylinder but Mr Kelleher refers to it as an Aussie Huanri brand cylinder. Exhibit E, page 80 of the coronial brief. Transcript pages 68-69.

he attributed to the cylinders falling from the truck onto the road surface. Analysis of the contents of the cylinders indicated that each contained low level residues of liquid petroleum gas. No other flammable gas was detected in any of the cylinders. Nor was there anything else in the rear compartment or debris field that could have provided the fuel for the explosion.[44]

57. Mr Kelleher's expert evidence was that there was a fuel-air explosion in the rear compartment of sufficient force to blow the roof, sides and rear door off the truck body. He calculated that approximately one kilogram of gas would have been required to cause an explosion of this magnitude.[45] Moreover, his evidence was that the absence of heat effects indicated a very lean fuel-air mixture, involving up to about one kilogram of gas.[46] The obvious source of the gas was one or more of the LPG cylinders all of which were found at least partly open.[47] In his estimation, the motion of the truck and the heat in the compartment on what was a very hot day, ensured the gas was both well-mixed and spread through most of the compartment, although the damage to the truck bed indicated the explosion was focused towards the front of the rear compartment. This suggested that only part of the compartment, perhaps the front half, contained a fuel-air mix within the explosive range of approximately 2-9%.[48]

58. To the extent that Mr Kelleher's evidence about movement and mixing of the gas with the air in the rear compartment is contrary to Mr O'Toole's evidence about "pooling" towards the bottom of the rear compartment as it was heavier than the ambient air, I prefer the evidence of Mr Kelleher on the basis of his formal qualifications and more specific expertise.

59. At inquest, Mr Kelleher expanded on his evidence as to the relevant explosive range, testifying that the absence of evidence of heat or fire damage (as opposed to blast force) indicated that the explosion resulted from a "lean" fuel-air mix closer to the 2% or lower end of the explosive range than the upper threshold of 9% where one would have expected more evidence of heat or fire damage.[49]

THE IGNITION SOURCE

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[44] Ibid and transcript page 73.
[45] Transcript page 76 and following.
[46] See transcript page 78 where in answer to a question about how such a small volume of gas could cause such an extraordinarily large blast, Mr Kelleher said "Well, because it's not a small volume of gas, the…kilogram is the weight of the gas but that works out to…roughly 250 litres and then it's mixed with air, so there's…49 times as much air is mixed with it and so the volume is tens of thousands of …litres of combustible air/gas mixture that we're talking about, so it's not…a small amount when you look at it from that point of view."
[47] Transcript pages 69 and following.
[48] Exhibit E, at pages 80-81 of the coronial brief and transcript page 70 and following. It was uncontentious that the explosion occurred on a hot day with temperatures in the high 20s to low 30s at the time.
[49] Transcript page 70 and following. Note in this regard that the pressure release valves on the three LPG cylinders did not operate as they would be expected to in the face of extreme heat. Transcript pages 78, 86.

60. Mr O'Toole also inspected three rechargeable 12 volt batteries found in the debris as potential ignition sources. Photographs of these batteries appear in the coronial brief and, for convenience, I will refer to them by their brand names – Axiom, CooPower and Rock.[50] The batteries had no caps on their terminals. According to Mr O'Toole, the safest way to transport them would have been with their terminals capped.[51]

61. Tests were conducted on the batteries the day after the incident. Mr O'Toole's evidence was that an amp meter indicated that the Axiom and CooPower batteries had 12 volts while the Rock battery had no charge at all. Moreover, the Rock battery bore evidence of heat damage to its plastic casing consistent with an arcing event. While Mr O'Toole allowed of the possibility that the Rock battery had a metal object resting on it in transit which may have drawn down its charge, in his opinion, the state of the battery was consistent with an arcing event in transit. In his estimation, this was the likely ignition source.[52]

62. In cross-examination, Mr O'Toole suggested other potential ignition sources such as the truck's electronic components, a hot exhaust or hot brakes but, as these were isolated from the rear compartment, he did not consider them viable. Nor did he think that a spark in the driver's compartment or metal hitting metal in the rear compartment, could have ignited the explosion.[53]

63. In his statement, Mr Kelleher detailed the potential ignition sources in the rear compartment or debris field, starting with the cigarette lighter found in Mr Carnevale's hand. He characterised this as entirely coincidental, as the driver's cabin was completely separated from the rear compartment and with a lean fuel-air mix inside the rear compartment, the fuel-air mix outside the rear compartment must have been leaner and therefore below the lower explosive limit.[54]

64. Apart from the rechargeable batteries inspected by Mr O'Toole, Mr Kelleher identified remote controls for various appliances the accidental operation of which may or may not be sufficiently energetic to ignite a fuel-air mixture; two keyless entry controls the accidental operation of which might cause a sufficiently energetic spark; and also allowed of the

[50] Depicted at pages 297, 298-299 and 301-302 of the coronial brief respectively.
[51] Transcript page 55.
[52] Transcript pages 54-55. See also transcript pages 56-57 for Mr O'Toole's evidence that when tested the day before the inquest (that is on 21 March 2017) the Rock battery had 11 volts - "Okay so you're saying that the charge has sort of, over time, has come back?---Yeah, 'cause there's a – the batteries um, rely on a chemical reaction within them so."
[53] Transcript page 61.
[54] Exhibit E, at page 81 of the coronial brief.

possibility that an interior light in the rear compartment, if switched on and hot, or if it sparked by some means, may have ignited the fuel-air mixture.[55]

65. While he could not exclude other ignition sources, Mr Kelleher's evidence was that a spark from one of the batteries was the probable ignition source, particularly in view of the evidence of arcing on one of the batteries.[56]

FINDINGS/CONCLUSIONS

66. The standard of proof for coronial findings of fact is the civil standard of proof on the balance of probabilities, with the *Briginshaw* gloss or explications. [57]

67. Adverse findings or comments against individuals or institutions are not to be made with the benefit of hindsight but only on the basis of what was known or should reasonably have been known or done at the time, and only where the evidence supports a finding that they departed materially from the standards of their profession, and in so doing caused or contributed to the death under investigation.

68. Having applied the applicable standard of proof to the available evidence, I find that:

    a. The explosion was not caused by a motor vehicle collision.

    b. Between 17 and 28 December 2015, Mr Zema loaded the truck with general household goods belonging to Mr Carnevale ahead of moving them to the Flemington storage unit.

    c. While Mr Zema recalled loading only two LPG cylinders that he placed in the rear compartment, closest to the rear doors, there were in fact were three LPG cylinders in the rear compartment and the valves of all were open to some extent.

    d. It is possible that Mr Carnevale loaded the third LPG cylinder.

    e. While the possibility of an unknown third person tampering with the LPG cylinders after they were loaded into the truck cannot be excluded, the investigation did not identify any such person or anyone with a motive to harm Mr Carnevale.

    f. The explosion occurred while Mr Carnevale was driving the truck east on Barkly Street, about ten metres past the intersection of Gordon Street, Footscray.

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[55] Ibid.
[56] Exhibit E, at page 82 of the coronial brief.
[57] *Briginshaw v Briginshaw (1938) 60 C.L.R. 336* especially at *362-363.* "The seriousness of an allegation made, the inherent unlikelihood of an occurrence of a given description, or the gravity of the consequences flowing from a particular finding, are considerations which must affect the answer to the question whether the issues had been proved to the reasonable satisfaction of the tribunal. In such matters "reasonable satisfaction" should not be produced by inexact proofs, indefinite testimony, or indirect inferences…"

g. The explosion was caused by a lean fuel-air mix of approximately one kilogram of gas in the rear compartment of the truck while it was underway – the relevant fuel being the gas that had leaked from one or more of the three LPG cylinders and the most likely ignition source being the uncapped Rock battery that showed evidence of arcing and a loss of charge.

h. The absence of a fire or significant heat damage in the debris indicates a lean fuel-air mix closer to the lower end of the explosive range of approximately 2-9% rather than at the higher end of the range.

i. Absent either the leaking LPG cylinders and the fuel-air mix, or the ignition source, there would have been no explosion.

j. Mr Carnevale died as a result of the head injury he sustained in the explosion. The severity of the head injury was such that he either died instantaneously or within moments of the explosion.

k. From a public safety perspective, it was entirely fortuitous that Mr Carnevale was the sole fatality. Had the explosion occurred in a more populous area, for example near a school or major shopping centre, there was the potential for a significantly greater loss of life.

PREVENTION FOCUSED ROUND TABLE CONFERENCE – 29 MAY 2017

69. In light of the circumstance, I asked the Coroners Prevention Unit [CPU] to report about any other coronial cases involving deaths in similar circumstances in order to understand the magnitude of the problem and to identify any common themes. They searched a database of all Victorian coronial cases from 1 July 2000 and also searched the National Coronial Information Scheme. For reasons that I will not labour here, CPU were not confident that all relevant deaths were able to be identified.

70. Regardless, CPU were able to identify four deaths of some relevance, two of which involved explosions in caravans or motor homes[58] and two of which appeared to have occurred in very similar circumstances to Mr Carnevale's death.[59]

[58] Finding into the death of James Partner 2002 1489. Mr Partner died following an explosion in his caravan. Several LPG gas cylinders used for cooking and heating were found in and around the caravan. The coroner found that there was no doubt that the explosion resulted from the pooling of LPG forming a lethal fuel air mixture inadvertently ignited by an unidentified ignition source within the caravan. The major issues considered by the coroner in the finding related to the odorisation processes for LPG.
Finding into the death of Francis James 2007 0795. Mr James died in an explosion during a camping trip which occurred when he attempted to light the pilot light on the LPG fridge installed in his motor home. Investigations determined the explosion was probably linked to gas leaking from a loose gas fitting in the motor home. The coroner's finding did not identify or address any issues relating to gas cylinder storage and ventilation.

71. My assistant, LSC Duncan McKenzie then sought the assistance of Energy Safe Victoria [ESV] to identify contact people or suitably qualified representatives from stake-holder organisations to assist in the formulation of prevention focused comments or recommendations.[60] ESV provided a list of contact people and they were, in turn, invited to participate in a round table conference at the Court on 29 May 2017. Included in the invitation was a summary of the circumstances in which Mr Carnevale's death occurred, broadly consistent with the circumstances set out in this finding.

72. At the round table conference, participants were provided with excerpts from the CPU report containing a summary of the four previous deaths identified by the CPU, photographs of the three LPG cylinders and the debris field and a copy of a paper dated 25 May 2017 prepared by Jason Treseder of ESV entitled "Discussion Paper on LPG Cylinder Valves". In addition, participants were shown real time footage of the explosion taken by a traffic safety camera at the Barkly and Gordon Streets intersection.

73. In an effort to encourage full and frank discussion, the round table conference was not formally scribed. Each participant was free to take their own notes. It was apparent that those present were familiar with the safety issues raised by the circumstances in which Mr Carnevale died, as they were aware of other similar incidents occurring from time to time which were the subject of ongoing discussion within the industry.

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[59] Finding into the death of Patrick Bird, Northern Territory case D0212/2011. Mr Bird was employed as a refrigeration mechanic and drove a van in which bottles of the flammable gases acetylene and MAPP (brand name for a gas used in many industries, the name of which is derived from its constituent gases methylacetylene and propadiene). According to the coronial finding the only ventilation for the van consisted of the driver and passenger windows which could be opened and closed whether partially or fully and the doors of the van which could be left open. The coroner found that the gas from one of the cylinders leaked overnight and filled the van. Mr Bird approached the van and activated its keyless entry device, which appears to have produced a spark that ignited the gas causing the explosion in which he died. The coroner noted the following – (1) The Material Safety Data Sheets for both acetylene and MAPP advised that cylinders should be stored in a well ventilated place. (2) The employer had documented methods and procedures for working with and transporting flammable gases, but these did not address the need for adequate ventilation of vehicles. (3) In any event, the employer did not provide any training to employees regarding the methods and procedures for working with and transporting flammable gases. (4) WorkSafe prosecuted the employer successfully and a number of safety improvements were introduced in the transport and storage of gas cylinders. Death of Joey Consentino 2011 4657. Mr Consentino was a refrigeration mechanic employed by Cool Dynamics Refrigeration P/L. He died in a gas explosion in his work van. The coroner discontinued the investigation after the employer was successfully prosecuted by WorkSafe for occupational health and safety breaches. However the following can be gleaned from the His Honour Judge Dean's sentencing remarks – (1) The work van had a gas cabinet for storing gas cylinders which was not vented. (2) The explosion was caused by ignition of flammable gas that collected in the van; there were three cylinders of three different flammable gases and it was not clear which was responsible for the explosion. (3) The explosion occurred just after Mr Consentino approached the van but the exact ignition source was not identified. Police investigators consulted several experts and made a number of recommendations including – that consideration be given to a prohibition of the carrying of oxy-acetylene cylinders within vehicles with enclosed cargo areas such as vans; that consideration be given to the fitting of an alarm to automatically monitor and detect oxygen levels and/or gas leakage within enclosed vehicles; and that brass plugs be fitted into the valve of oxy-acetylene cylinders after the gauges have been removed and prior to the storage/transport of the cylinders to prevent leakage.

[60] For example Swap 'N Go, Kwik Gas, the LPG Safety Committee, MFB, WorkSafe.

74. Discussion focused on two aspects of the circumstances in which Mr Carnevale died – the fact that all three LPG cylinders were found to have been in a partially opened state and the fact that they were being transported in a closed compartment, effectively within a confined space.

75. It became apparent that the problem of people leaving LPG cylinder valves open or partially open was well-known within the industry and had been on the agenda to be fixed for some time. The inherent risks were compounded whenever LPG gas cylinders were transported, as they commonly were, in a closed vehicle compartment.

76. An example of a safety valve was produced by way of illustration. This valve does not allow gas to flow unless the cylinder is coupled to an appliance such as a barbeque and thereby minimises the risk of cylinder valves being inadvertently left open.

77. I was advised that some ten years earlier, New Zealand had legislated for such a valve to be compulsory, as had the United States of America some twenty years ago. Presumably, any lessons learned from those comparable jurisdictions would be available to the relevant Victorian or Federal authorities or Standards Australia.

78. Furthermore, cost does not appear to be prohibitive with an estimated additional cost of $1-$2 per LPG cylinder, depending on which safety valve was chosen. I note in this regard, the advice that safety could be further enhanced by the addition of a thermal fuse which would stop the flow of gas once the cylinder reached a certain temperature and, in the event of fire, would assist to mitigate the risk or extent of the fire or of a consequential explosion.

79. There was consensus among participants that the best mechanism to achieve uniformity across the various Australian jurisdictions was by amendment of the relevant Australian Standards which could be a lengthy process even when there was broad consensus but which would obviate the need for each state and territory to legislate for change.

80. I wish to formally record my thanks to Energy Safety Victoria, in particular to Mr Justin Treseger for authoring the discussion paper; to all participants at the round table conference for giving generously of their time and significant expertise; and to my assistant LSC McKenzie and coronial investigator DSC Jeremy Hart for their ongoing interest and assistance to me in this investigation.

COMMENTS

Pursuant to section 67(3) of the ***Coroners Act 2008,*** I make the following comment/s on a matter connected with the death:

1. The circumstances in which Mr Carnevale's death occurred highlights that safe transportation of batteries involves the capping of their terminals and securing them so as to minimise the risk of movement and sparking.

2. LPG cylinders such as those implicated in this tragic death are a ubiquitous household item, as useful when used properly as they are potentially dangerous when appropriate safety precautions are not taken.

2. The circumstances also highlight the danger of leaving LPG gas cylinder valves open or even partially open when not in use and, the even greater danger inherent in transporting cylinders in a closed compartment. This poses a particular risk to public safety as such cylinders are typically transported in a motor vehicle for swapping, more than likely the boot of the family car.

3. Safety labelling attached to LPG cylinders intended for domestic use is usually attached in such a way that it has to be removed before first use. While such a strategy may encourage people to read the label before first use of the LPG gas, it is not the best strategy for ensuring ongoing adherence to safety precautions or for protecting subsequent users.

4. Public safety would be enhanced by safety information being inscribed on the LPG cylinder itself so that it would be available to all users and/or by attachment of safety labels in such a way that they remain attached to the cylinder during its service life.

5. Public safety would be significantly enhanced by amendment of the relevant Australian Standards (including but not limited to AS 1596 'Storage and Handling of LPG gas'; AS2030 series 'The approval, fitting, inspection, testing and maintenance of cylinders for the transport of compressed gases'; AS 2473 parts 1 and 2 'Valves for compressed gas cylinders') so as to mandate the use of safety valves that will minimise the risk that a cylinder will be left inadvertently opened or partially opened, particularly during transportation from one place to another.

6. But for the reference in section 72(2) ***Coroners Act 2008*** to "any Minister, public statutory authority or entity" which does not encompass Standards Australia within the class of people or institutions to whom recommendations can be addressed, I would have made a recommendation in the terms of comment 5, above.

RECOMMENDATIONS

Pursuant to section 72(2) of the *Coroners Act 2008,* I make the following recommendation/s on a matter connected with the death:

1. That Energy Safe Victoria consider implementation of a public awareness campaign about the need to ensure that LPG gas cylinders valves are closed whenever they are not in use, particularly when they are being transported, and that, wherever possible, they are transported in an open or vented vehicle compartment.
2. That, in the alternative to comment 5 above, the Victorian government consider legislating so as to require that all LPG cylinders intended for domestic use are fitted, as a minimum, with a safety valve that will not allow the flow of gas unless the cylinder is coupled to an appliance, and, optimally, that they are also fitted with a thermal fuse or other mechanism that will prevent the flow of gas in the face of extreme heat or fire.

I direct that a copy of this finding be provided to:

The family of Mr Carnevale

Mr Zema

The Honourable Lily D'Ambrosio, Minister for Energy, Environment and Climate Change

Standards Australia

Transport Accident Commission

Det Sen Const Jeremy William Hart (#35495) c/o OIC Altona North Police Station

<u>Participants at the Round Table Conference:</u>

David Collins, CEM International Pty Ltd

Steven Cronin, Energy Safe Victoria

John Griffiths, Gas Energy Australia

David Hamilton, Origin Energy

Alexis Hurwitz, WorkSafe Victoria

Lewis Nottidge, Elgas

Darryl Ramm, Gas Energy Australia

Steve Reynolds, Elgas

Clay Roberts, Kleenheat

Adrian Simonetta, WorkSafe

Jason Treseder, Energy Safe Victoria

Chris Wealthy, Australian Gas Association

Signature:

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PARESA ANTONIADIS SPANOS
Coroner
Date: 30 September 2018