FORM 37

Rule 60(1)

FINDING INTO DEATH WITH INQUEST

Section 67 of the ***Coroners Act 2008***

Court reference: 2652/04

Inquest into the Death of GEOFFREY BROCKIE

Delivered On: 30 September, 2011

Delivered At: Coroners Court of Victoria
Level 11, 222 Exhibition Street,
Melbourne 3000

Hearing Dates: 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 20, 21 August 2008

Findings of: Coroner Paresa Antoniadis SPANOS

Representation: Counsel Assisting the Coroner - Mr John LANGMEAD S.C. with Ms Deborah SIEMENSMA of Counsel, instructed by Mr David RYAN, Victorian Government Solicitor's Office.

Mr Ian HARVEY of Counsel, instructed by Mr Peter McQUEEN, Blake Dawson Waldron, on behalf of Air Services Australia.

Mr RIBBANDS of Counsel, instructed by Mr Brian WARD, Flower & Hart, on behalf of the Civil Air Operations Officers Association of Australia/the Air Traffic Controllers.

Mr Gary LIVERMORE of Counsel, instructed by Mr Paul BARKER, Australian Government Solicitor's Office, on behalf of the Australian Transport Safety Bureau.

Mr Jay ANDERSON of Counsel, instructed by Mr John Dawson of Carneys Lawyers, on behalf of the HENDERSON family.

FORM 37

Rule 60(1)

FINDING INTO DEATH WITH INQUEST

Section 67 of the ***Coroners Act 2008***

Court reference: 2652/04

In the Coroners Court of Victoria at Melbourne

I, PARESA ANTONIADIS SPANOS, Coroner

having investigated the death of:

Details of deceased:

Surname:	BROCKIE
First name:	GEOFFREY
Address:	11/16 Eleovera Road, Cronulla, New South Wales 2230

AND having held an inquest in relation to this and other deaths at Southbank

on the 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 20, 21 August 2008

find that the identity of the deceased was GEOFFREY BROCKIE

and death occurred on 28th July, 2004

at Boggy Creek Road, Myrrhee, Victoria 3732

from: 1(a) INJURIES SUSTAINED AS A RESULT OF AVIATION ACCIDENT

in the following circumstances:

INTRODUCTION

1. Mr Brockie was one of five passengers of a Piper PA-31T Cheyenne aircraft, registration VH-TNP (TNP) which departed Bankstown Airport New South Wales, on the morning of 28 July 2004 on a flight to Benalla Airport in North-Eastern Victoria. The other passengers were Ms Belinda Andrews, Ms Jacqueline Henderson, her father Mr Robert Harold Henderson, and her husband Mr Alan Donald Stark. The pilot was Mr Kerry Endicott. The flight was conducted pursuant to the instrument flight rules (IFR) in instrument meteorological conditions (IMC). In his last communication with air traffic controllers at 10.45.08, Mr Endicott reported that he was commencing a GPS approach at Benalla, changing to the appropriate radio frequency for Benalla Airport and expecting to have landed by 10.55am.[1] Shortly before 11.00am, the flight ended in a collision with terrain, in the vicinity of Boggy Creek Road, Myrrhee, some 34 kilometres south-

[1] There are many reference to this communication in the coronial brief and the inquest transcript but it is most accessible in the ATSB report at 214 of the coronial brief or CB 214 - see footnote 4.

east of Benalla. All six occupants were fatally injured upon impact and TNP destroyed by impact forces and the ensuing fire.

2. Mr Endicott held an Air Transport Pilot Licence, the highest category of licence available in Australia and was considerably experienced with in excess of 14,000 hours of flying experience. He held a command instrument rating which qualified him to fly in accordance with the IFR, including the use of the Global Positioning System (GPS). He was very familiar with the type of aircraft, having some 3,100 hours of experience on the Piper Cheyenne, and with TNP in particular which he had flown regularly since 1988. Mr Endicott was also familiar with the Bankstown to Benalla route, having flown the route or variations of it, at least weekly since 1988.[2]

3. The aircraft which was owned by Lampion Pty Ltd, a company associated with the Henderson family,[3] was described during the inquest as a sophisticated twin engine turbo prop which was pressurised and well equipped in terms of avionics for IFR flights. Although the extent of impact and post-impact damage confounded examination of the aircraft's navigation and flight control systems so there is no positive verification that they were operating properly during the flight, there was no evidence found of any defect within those systems, including the GPS system fitted to the aircraft which was a Trimble 2101 I/0 Approach Plus GPS (Trimble). Similarly, a review of the aircraft's maintenance documentation indicated that it had been appropriately maintained.[4]

THE FOCUS OF THE CORONIAL INVESTIGATION

4. Accepting nevertheless that pilot error and/or some defect in the aircraft's navigation and flight control systems could not be entirely excluded as causative or contributing factors to the collision, the focus of this coronial investigation was threefold -

- Was the pilot medically incapacitated?
- Were the air traffic controllers' interactions with TNP in accordance with their obligations and/or otherwise adequate?
- Was there any interruption to GPS coverage and/or did the Trimble GPS operate in such a way as to cause or contribute to the collision?

EVIDENTIARY SOURCES

5. This finding is based on the totality of the material, the product of the coronial investigation of the deaths of the six deceased, that is the coronial brief compiled by Sergeant David Dimsey from the Police Coronial Support Unit, the statements and testimony of those witnesses who testified at the inquest and any documents tendered through them, a simulation/replay of the displays on the screen of the relevant air traffic controllers,[5] and the submissions of Counsel. The coronial brief included the investigative report of the Australian

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2 CB 196 and following.

3 According to Mr David Henderson's evidence at inquest transcript page 730 or T730, he was co-director with his brother Mr Robert Henderson of D & R Henderson Pty Ltd. Lampion Pty Ltd was an associated company incorporated to acquire and operate the aircraft TNP for charter and holder of the relevant Air Operator's Certificate. See also T737, 758-9.

4 CB 198 and following.

5 This was a real time replay which involved all counsel and took place at Melbourne Centre/Melbourne Airport on 5 August 2008.

Transport Safety Bureau (the ATSB report) which is a publicly available report,[6] and the investigative report of Airservices Australia (the ASA report) which is a confidential report,[7] in the sense that, while it was provided to me for the purposes of the coronial investigation and made available to the parties, it is not publicly available.

6. All the material referred to above, together with the inquest transcript will remain on the coronial file, and may be accessed by application under section 115 of the *Coroners Act 2008.* In the event of an application seeking access to the ASA report, the matter will be listed for hearing and notice being given to all parties, as determined during the course of the inquest.[8]

7. In part, due to the publication of the ATSB report and in part because the facts pertaining to the progress of the flight are largely uncontroversial, I do not purport to summarise all the material/evidence in this finding, but will refer to it only in such detail as is warranted by its forensic significance and narrative clarity. To this end, consistent with their use at inquest, I have attached the following graphic aids to this finding which were used during the inquest, as a means of communicating detailed and technical material more effectively than words.

THE PURPOSE OF A CORONIAL INVESTIGATION

8. The primary purpose of the coronial investigation of a *reportable death*[9] is to ascertain, if possible, the identity of the deceased person, how death occurred, the cause of death and the particulars needed to register the death - effectively, the date and place where the death occurred.[10] In order to distinguish *how* death occurred from the *cause* of death, the practice is to refer to the latter as the *medical* cause of death, incorporating where appropriate the *mode or mechanism* of death, and the former as the context, or background and surrounding *circumstances.* These circumstances must be sufficiently proximate and causally relevant to the death, and not merely circumstances which might form part of a narrative culminating in death.[11]

9. A secondary purpose of the coronial investigation arises from the coroner's power to report to the Attorney-General on a death; to comment on any matter connected with the death

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6 The initial ATSB report appears at pages 181-241 of the coronial brief, hereinafter referred to as CB 181-241. Evidence heard during the inquest as to possible problems with the GPS unit installed in the subject aircraft lead to ATSB re-opening their investigation and following the conclusion of the inquest an amended report was published by the ATSB in February 2009, addressing this issue. References in this finding will be to the initial ATSB report unless otherwise indicated (as indeed they are in the inquest transcript).

7 The ASA report appears at CB 103-148.

8 Inquest transcript at pages , hereinafter referred to as T

9 As this inquest commenced prior to 1 November 2009, the commencement date of the *Coroners Act 2008,* the substantive legislation which applies is the *Coroners Act 1985.* Unless otherwise specified, all references to legislation which follow will be to the provisions of the 1985 Act. The definition of a reportable death in section 3 of the 1985 Act includes all deaths from accident or injury, but also required a jurisdictional nexus with Victoria - "reportable death" means a death ...where the body is in Victoria; or that occurred in Victoria; or the cause of which occurred in Victoria; ..." Clearly, the deaths under investigation fall within this definition and no threshold jurisdictional issues were raised on this or any other basis.

10 Section 19(1).

11 Paraphrasing and at the risk of over-simplifying *Harmsworth v The State Coroner [1989] V.R. 989; Clancy v West (Unreported decision of Harper, J in the Supreme Court of Victoria, 17/08/1994); cf Thales Australia Ltd v The Coroners Court & Ors [2011] VSC 133.*

they have investigated, including public health or safety or the administration of justice; and to make recommendations to any Minister or public statutory authority on any matter connected with the death, including public health or safety or the administration of justice.[12] Whilst the *Coroners Act 1985* which governs this investigation does not explicitly refer to the purpose of any such reports, comments or recommendations made by a coroner, the implicit and generally accepted purpose, is the prevention of similar deaths in the future.[13]

10. A coroner is not empowered to determine civil liability or to apportion blame, and is specifically prohibited from including in a finding or comment, any statement that a person is or may be guilty of an offence.[14] Therefore, whether or not it encompasses an inquest, a coronial investigation is best seen, not as a trial or contest between opposing parties, but as an investigation or inquiry into the facts so as to determine how the deaths occurred and how similar deaths may be prevented in the future.[15]

UNCONTENTIOUS MATTERS

11. Upon consideration of the coronial brief and prior to the commencement of the inquest, it was apparent that a number of the matters required to be ascertained by a coronial investigation were uncontentious. These were the deceased's identities, the medical cause of their deaths, the date and place of death and aspects of the circumstances. I accordingly find as a matter of formality that -

- Belinda Anne Andrews, born on the 16 March 1970, late of 39 Landers Road, Lane Cove, New South Wales, died from injuries sustained as a result of an aviation accident in which she was a passenger, on 28 July 2004, in the vicinity of Boggy Creek Road, Myrrhee.

- Geoffrey William Brockie, born on the 26 December 1966, late of 11/16 Eleovera Road, Cronulla, New South Wales, died from injuries sustained as a result of an aviation accident in which he was a passenger, on 28 July 2004, in the vicinity of Boggy Creek Road, Myrrhee.

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12 Sections 21(1), 19(2) and 21(2) respectively re reports, comments and recommendations.

13 This is to be contrasted with the *Coroners Act 2008* which came into operation on 1 November 2009 (and applies to inquests commencing after that date) and in its Preamble and Purposes explicitly refers to the coroner's role in contributing to the reduction of preventable deaths through findings and the making of recommendations - section 1(c).

14 This gives rise to something of a paradox, as a coroner is required to report the matter to the Director of Public Prosecutions, if at the conclusion of investigation, the coroner believes that an indictable offence has been committed in connection with a death - sections 19(3) and 21(3).

15 Several authorities grapple with the nature of a coronial investigation - for example *Harmsworth v the State Coroner [1989] V.R. 989; Militano v The State Coroner (Supreme Court of Victoria, unreported decision of Mr Justice Hayne, 18 December 1992)* and, notably, *R* v *South London Coroner, ex parte Thompson [1982] 126 SJ 625 per Lord Chief Justice Lane* -" An inquest is a fact-finding investigation and not a method of apportioning guilt ... the procedure and rules of evidence which are suitable for one are unsuitable for the other. In an inquest, it should never be forgotten that there are no parties, there is no indictment, there is no prosecution, there is no defence, there is no trial - simply an attempt to establish facts ." The "prevention" role considered implicit in the *Coroners Act 1985,* is now explicitly articulated in the purposes and preamble to the *Coroners Act 2008.*

- Kerry David Endicott, born on the 8 May 1935, late of 3 Acres Road, Kellyville, New South Wales, died from injuries sustained as a result of an aviation accident in which he was the pilot, on 28 July 2004, in the vicinity of Boggy Creek Road, Myrrhee.

- Jacqueline Henderson, also known as Jacqueline Mary Henderson, born on the 15 March 1971, late of 11 Rural View Drive, Rural View, Mackay, Queensland, died from injuries sustained as a result of an aviation accident in which she was a passenger, on 28 July 2004, in the vicinity of Boggy Creek Road, Myrrhee.

- Robert Henderson, also known as Robert Harold Henderson, born on the 18 December 1941, late of 38 Malton Road, Beecroft, New South Wales, died from injuries sustained as a result of an aviation accident in which he was a passenger, on 28 July 2004, in the vicinity of Boggy Creek Road, Myrrhee.

- Alan Donald Stark, born on the 2 August 1967, late of 11 Rural View Drive, Rural View, Mackay, Queensland, died from injuries sustained as a result of an aviation accident in which he was a passenger, on 28 July 2004, in the vicinity of Boggy Creek Road, Myrrhee.

WAS THE PILOT MEDICALLY INCAPACITATED?

12. Dr Shelley Robertson[16] is a senior forensic pathologist from the Victorian Institute of Forensic Medicine (VIFM) with specialisation in aviation incidents, who performed full post-mortem examinations or autopsies on each of the deceased. The genesis of this issue was in the autopsy report regarding Mr Endicott[17] in which autopsy findings were summarised as extensive heat damage, possible traumatic rupture of the aorta and *moderate to marked coronary atherosclerosis.*

13. Dr Robertson attributed Mr Endicott's death to injuries sustained in an aviation accident noting ischaemic heart disease as a contributory factor. She advised that changes within the respiratory tract indicated that he was alive for a short time following impact and during the fire.[18] Noting verapamil and its metabolite norverapamil in postmortem toxicological analysis, Dr Robertson advised that this was a drug used in the treatment of cardiac conditions including arrhythmias and a Class "C" medication for the purposes of the Civil Aviation Safety Authority (CASA). That is, it was a drug which may be compatible with aviation duties but which required specific assessment by CASA.

14. In terms of the extent of marked coronary atherosclerosis found at autopsy, Dr Robertson commented that there was up to 70% luminal narrowing of the major coronary vessels of such a severity as to be considered a probable cause of sudden cardiac death in the absence of other pathological findings,[19] and that it is likely that a sudden cardiac event may have caused some degree of pilot incapacitation given the extent of the natural disease present, which may have

16 Dr Robertson's formal qualifications and experience are outlined in the preamble to each autopsy report - see CB 5-59.

17 CB 18-19.

18 Toxicological analysis did not detect a carboxyhaemoglobin saturation (<5%) indicating that Mr Endicott was not alive long after commencement of the fire CB 19-20.

19 In the body of the autopsy report under "Cardiovascular System", as opposed to its conclusion, Dr Robertson notes "...atheroma causing up to 70% luminal narrowing of the left anterior descending and circumflex coronary arteries in a patchy distribution. The right coronary artery was a small vessel that did not appear significantly atheromatous." CB 17.

been precipitated or exacerbated by other factors causing stress such as adverse weather conditions.

15. At inquest, Dr Robertson was cross-examined about her meaning. She testified that, in the absence of other natural disease or traumatic injury, the severity of the coronary atherosclerosis was such that she would have had no hesitation in attributing death to that disease. Dr Robertson clarified that her assessment of 70% luminal narrowing was just that, and was not cross-sectional.

16. When the opinions of other medical practitioners were put to her, she maintained that the possibility Mr Endicott had suffered a cardiac event immediately preceding impact, could not be excluded. Dr Robertson went further in maintaining that Mr Endicott had a significant pathological condition which certainly couldn't be excluded and may well have contributed to its occurrence. In her opinion, the high degree of cognitive workload associated with a difficult approach/landing in inclement weather could have precipitated a cardiac event in the presence of the underlying cardiac disease found at autopsy.[20]

17. Other evidence of Mr Endicott's medical condition was provided by his general practitioner Dr John Miller from Castle Hill, New South Wales,[21] and his treating cardiologist Dr James Wong from the Sydney Cardiology Group,[22] neither of whom were required to attend the inquest. They confirmed that Mr Endicott had chronic atrial fibrillation first diagnosed in April 2000 and treated with Isoptin (verapramil) for heart rate control and Coumadin (warfarin) for anticoagulation.

18. Dr Wong advised that when last seen in April 2004, Mr Endicott had no symptoms of myocardial ischaemia and that he underwent a maximal treadmill exercise test which showed no clinical or electrocardiographic evidence of significant myocardial ischaemia. Doppler echocardiogram showed normal left ventricular function. Dr Wong considered that Mr Endicott's cardiac status was satisfactory and did not warrant further invasive investigation. Commenting on the autopsy findings he stated that Mr Endicott "... clearly had severe obstructive coronary disease. This does not necessarily indicate that [he] suffered an ischaemic event, but it is possible. This is turn may have been associated with other factors which may have caused stress. However, the findings may also be incidental and myocardial ischaemia may not have occurred." [23]

19. A report was provided by Dr Ian Hosegood, Principal Medical Officer, CASA Office of Aviation Medicine who was not required to attend the inquest. He advised that after diagnosis of atrial fibrillation, CASA protocols required that Mr Endicott be certified medically fit each twelve months. Commencing in July 2000, Mr Endicott met the requirements at each renewal. According to Dr Hosegood, "The initial negative exercise perfusion scan and subsequent exercise stress tests have a good negative predictive value for cardiac events (specificity in the 80-90% range) and this improves further when combined with the Dopler echocardiograms. This means that with ongoing negative stress tests each 12 months, there was a very low probabilistic risk of an incapacitating cardiac event. Continued aviation medical certification of Mr Endicott was therefore reasonable."[24] Commenting on the general circumstances, Dr Hosegood noted that any incapacitation would have been partial rather than complete as Mr Endicott was alive for a period

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20 T575-581.
21 CB 77-78.
22 CB 79-81.
23 CB 80-81.
24 CB 82-84, esp 83.

after impact, that there was nothing about the circumstances to indicate either subtle or sudden pilot incapacitation, and that an experienced pilot with an instrument rating was unlikely to be unduly stressed by flying in IMC.[25]

20. Consultant Cardiologist Dr Peter Habersberger testified that some degree of coronary atherosclerosis is present in the majority of men over the age of 68, although a large number are completely asymptomatic and that this was the reason for regular exercise testing of pilots in particular, to ascertain whether there is any functional deficit and/or myocardial ischaemia. If Mr Endicott had any clinical evidence of myocardial ischaemia, there would be an increased likelihood of myocardial infarction and/or sudden death, particularly under circumstances of stressful physical or mental activity, such as flying in cloud might produce.[26] Dr Habersberger's opinion was that a 70% stenosis in the left anterior descending coronary artery, did not indicate that the accident was caused by a sudden cardiac death, particularly as Mr Endicott had a negative stress test only three months before.[27] He assessed the likelihood of a sudden cardiac arrhythmia leading to immediate death as an unlikely possibility, but allowed the possibility that Mr Endicott may have experienced pain/discomfort, or other cardiac symptoms such as dizziness, vertigo, or fainting especially in a stressful environment.[28]

21. The weight of cogent evidence regarding Mr Endicott's cardiac history does not support a positive coronial finding that coronary artery atherosclerosis, ischaemic heart disease or any other naturally occurring disease in Mr Endicott, either caused or contributed to his death or the accident. While the possibility of a causally relevant cardiac episode cannot be entirely excluded, it is a mere possibility, given other circumstantial evidence. As noted by Dr Hosegood, "No mayday or other unusual radio calls were made and there was no suggestion of any actions consistent with such an incapacitation event such as a missed approach or takeover by one of the other competent pilots in the aircraft ... Normal radio calls were made long after the aircraft had diverted from its cleared GPS approach."[29]

WAS THE AIR TRAFFIC CONTROLLERS' INTERACTION WITH TNP IN ACCORDANCE WITH THEIR OBLIGATIONS AND/OR OTHERWISE ADEQUATE?

22. Resolution of this aspect of the circumstances requires some appreciation of airspace regulation in Australia, and of the largely uncontroversial progress of TNP from its 9.06am departure from Bankstown Airport until about 10.23am.[30]

23. While there is considerable freedom of the skies over most of the continent, in areas of high air traffic density such as around capital cities or regional airports, there is a system of regulation which involves the delineation of sectors or three-dimensional volumes of airspace which are controlled in the sense that ingress egress and flight path within, are regulated by Airservices Australia (ASA) through Air Traffic Control/Controllers (ATC). Pilots within controlled airspace are required to lodge a flight plan and to obtain from ATC, and abide, an airways clearance.[31] This is an authority to fly at a specific heading or route, at a specific altitude or flight level.

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25 CB 82. Some of these expressions are terms of art which will be explained below.
26 CB 84A-84B and T1055-1058.
27 Ibid and T1060.
28 T1060-1061.
29 CB82.
30 These matters were set out in greater detail in opening addresses commencing from T19-87.
31 *Civil Aviation Regulations 100(1) and (2).* Exhibit 17 excerpt of relevant A.I.P. Australia provisions - 19.4.1; 19.4.7(d); 19.4.8; 19.4.2(b)(4).

24. The flight was conducted pursuant to the instrument flight rules (IFR) as opposed to the visual flight rules (VFR). The latter applies where conditions allow the pilot to see outside the cockpit, to see a horizon and a certain distance in front of and around the aircraft. The former applies where there is little or no visibility. Pursuant to the IFR an aircraft can take off and enter cloud and fly an entire flight without external visual references, except that there must be adequate visibility at the destination to allow safe landing.

25. The approach and intended landing at Benalla Airport was to be by way of GPS Non Precision Approach (NPA). This is a structured approach using GPS navigation and GPS waypoints being locations coded into the GPS database. The runway at Benalla is in a westerly direction approximately, and there are three designated waypoints or approach points. **Attachment 2** shows the lateral aspects of the GPS NPA approach for Benalla, overlaid over a map of the region. In order to conduct a GPS NPA approach the pilot needs to be at a given waypoint at a specified height, to turn on to the correct heading for next waypoint and to descend so as to reach it at a specified height. **Attachment 3** is an approach chart which shows the lateral and vertical structure of the GPS NPA at Benalla Airport.

26. The Australian Advanced Air Traffic System (TAAATS) based on a European prototype was introduced by Airservices Australia (ASA) in 2000. Introduction was a significant project involving installation of hardware, purchase and modification of software, progressive roll-out and extensive training of air traffic controllers. Amongst other features, TAAATS incorporates a number of alarms and alerts to assist ATCs in the performance of their role. The alert which is most relevant to this inquest is the Route Adherence Monitoring or RAM alert which is set to activate when an aircraft deviates more than 7.5 nautical miles from its cleared route or track. The RAM alert has both an aural and a visual component. While the aural alert can be simply cancelled, the visual component remains displayed until the RAM alert is considered and resolved by the ATC.

27. TNP departed Bankstown Airport at 9.06am with an IFR flight plan that would see it fly over Canberra and Albury before descending to Benalla Airport. This was typically the route flown by Mr Endicott in TNP approximately weekly.[32] En route, TNP requested and was granted a clearance to divert to Jervis Bay and rejoin the flight plan route via Canberra at 22,000 feet. It seems likely that this diversion was for sight-seeing purposes.[33] In any event, there is no suggestion that there was anything untoward in Mr Endicott seeking a new clearance to divert to Jervis Bay and the ATC grant of a new clearance.

28. At 9.42.33am the Wollongong ATC received a route adherence monitoring alert (RAM) on her air situation display or screen. She made radio contact with TNP 25 seconds later and, in response to a request for clearance direct to Albury,[34] checked its viability before offering such a clearance at 9.45.44am, again at 22,000 feet. The flight data record (FDR) held in TAAATS was duly amended and a new RAM corridor thereby established in respect of TNP. Recorded data shows that although TNP turned right or tracked in a more westerly direction, it did not track directly to Albury.

29. At 9.52.52 whilst in the Benalla sector, TNP asked for and was granted a direct clearance

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32 Mr David Henderson's evidence T734 and following. CB229 shows route flown on 7 July 2004.

33 T767.

34 As is depicted on attachment 1, TNP was abeam Canberra at this time, on a heading which would not see it rejoin its initial flight plan at Canberra, without a change of heading.

to waypoint Benalla Echo Delta (BLAED) for a GPS approach to Benalla Airport.[35] Attachment 2 depicts GPS waypoints for Benalla Airport, overlaid on a map of that part of north-eastern Victoria. The Benalla ATC duly amended the FDR held in TAAATS and a new RAM corridor was thereby established in respect of TNP. This was the last clearance issued to TNP. A shift change around 10.00am involved handover of TNP between the outgoing Benalla ATC and the Mr Hodge as the incoming Benalla ATC, on the basis that the aircraft was cleared direct to BLAED maintaining flight level 20,000 feet.

THE FIRST ROUTE ADHERENCE MONITORING (RAM) ALERT @ 10.23.18AM

30. Although actually the second RAM alert in respect of TNP on 28 July 2004 - the first having been resolved by the Wollongong ATC as discussed above - the RAM alert at 10.23.18am was the first of the two RAM alerts scrutinised at inquest, not so much to ascertain what was done by the relevant ATCs to resolve the RAM alerts, but in order to assess the adequacy of what was done, and to assess if any shortcomings could be said to have caused or contributed to the accident.

31. From 9.53am to 10.45am, TNP deviated from its cleared track at a constant angle of about 4 degrees which translated to a deviation to the south or left of its cleared track by about 4 nautical miles for every 60 nautical miles flown. This is most conveniently illustrated on attachment 1 which affords a comparison of TNP's cleared track to BLAED (shown in red) and the radar derived track as flown (shown in purple).

32. At 10.23am when the "first" RAM alert was triggered by TNP indicating that the aircraft was 7.5 nautical miles off its cleared track, the Benalla ATC was Mr Hodge. At about the same time and before ascertaining the reason for the RAM alert, Mr Hodge handed over control of TNP to Mr Carey as the Snowy/Ovens ATC. Mr Hodge did however acknowledge the RAM alert which had the effect of silencing the aural alert. While the RAM alert was displayed on the air situation displays (ASDs) of both controllers, Mr Carey took jurisdiction over TNP with RAM alert unresolved.[36]

33. The Manual of Air Traffic Services (MATS) clearly envisages that there will be situations where an aircraft subject to an alert (including a RAM alert) may be handed over to another sector.[37] As the transferring controller, Mr Hodge was responsible for the initial assessment and resolution of the RAM alert.[38] Mr Hodge's evidence at inquest in this regard lacked internal consistency and sat uncomfortably with the terms of MATS section 6.5.11. For example, Mr Hodge testified that he believed that he had resolved the RAM by handing it over to Mr Carey who would resolve it, and later in cross-examination agreed that he didn't get to the cause of the RAM alert.[39] This despite being in communication with Mr Endicott at 10.24am as part of the handover, when he could have simply asked him about the apparent deviation from cleared track.[40]

34. Mr Butcher was an experienced former air traffic controller who held the position of Safety Manager, within the safety branch of Air Services Australia (ASA). He lead the ASA

35 CB138.
36 CB118-119.
37 Exhibit 16 was a copy of the Manual of Air Traffic Services as at July 2004-section 6.5.11.
38 Exhibit 16 MATS section 6.5.11.2.
39 T171-172, 214.
40 T231-232. CB139.

internal investigation of the accident and testified at inquest about a range of matters, including their conclusion that although Mr Hodge had arguably failed to conduct an "initial assessment and resolution" of the RAM alert as required by MATS 6.5.11.2, no causal connection could be made between such a failure and the accident.[41]

35. Neither Mr Beadle nor Mr Curran were critical of Mr Hodge's decision to transfer control of TNP to the Snowy/Ovens controller while it was still subject to the RAM alert. Both were experienced former air traffic controllers. While Mr Beadle was effectively a witness called on behalf of Mr Hodge and Mr Carey, Mr Curran currently holds a senior management position within ASA. While there were some notable areas of conflict between their evidence, in particular arising from their different interpretations of MATS 2.8.7 Route Adherence Monitoring (RAM) and its application to this accident, they agreed that there was nothing untoward about the handover of TNP whilst subject to a RAM alert.[42]

36. The weight of the above evidence does not support a finding that Mr Hodge's transfer of the aircraft to Mr Carey while subject to the RAM alert either caused or contributed to the accident. I accordingly make no adverse finding or comment against him and none should be inferred. If, as appears at least arguable, Mr Hodge did not discharge his responsibility under MATS 6.5.11.2 for "initial assessment and resolution" of the alert, that is at best a matter for another forum.

MR CAREY'S RESOLUTION OF THE 10.23.18 RAM ALERT

37. Between this RAM alert and the accident, Mr Carey was the Snowy/Ovens ATC. The aircraft was depicted on his screen at its location according to radar returns, with a label bearing its registration TNP, its actual altitude, and its last cleared waypoint or destination "ED".[43] The GPS waypoints for Benalla Airport were available on screen, as was a zoom function.[44] In order to ascertain why the RAM alert had activated and to resolve it, Mr Carey selected the velocity vector[45] and the route function from amongst the tools available to him on screen.

38. At 10.25am when Mr Endicott contacted Mr Carey after being instructed to change frequency, he was not advised of any tracking deviation. Nor did Mr Carey cancel the RAM alert at this time. At 10.28.09am Mr Endicott requested clearance to descend for the approach to Benalla Airport. At 10.33am when he was at about 17,000 feet, Mr Carey gave him clearance to leave controlled airspace on descent to Benalla via GPS approach. Mr Endicott read back the clearance in terms, as required. Neither of them referred to the specific GPS waypoint, being

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41 T888-890. CB128-129.

42 Mr Beadle's evidence on this issue is at T426-427 - "I would consider that it is the normal practice for controllers to assist each other in managing their workload." Mr Curran's evidence on this issue is at T1119-1122 - "On the basis of that discussion or a discussion like that took place it was a practical solution to what is a real world operation." See also T285 where Mr Carey testified that one of the reasons he agreed to resolve the RAM alert was that he had a lesser workload than Mr Hodge at that time.

43 I note that, in the course of resolving a potential conflict between TNP and another aircraft at 10.22am, Mr Hodge had asked TNP to advise his "descent point" and Mr Endicott had indicated 65 miles from BLAED. Mr Hodge passed this information onto Mr Carey in the course of handover.

44 T289.

45 The velocity vector is a graphic representation attached to a radar track which indicates the groundspeed and heading of the aircraft as calculated at the last radar update. This has variable settings with a time value of up to 5 minutes and is set globally for all radar tracks on screen. At this time the velocity vector on Mr Carey's screen was set at 4 minutes.

ED in accordance with his clearance. It was at this point in time, some 10 minutes after it had activated, that Mr Carey amended the flight data record for TNP held in TAAATS thereby cancelling the RAM alert and establishing a new RAM corridor for TNP from its current position direct to BLAED.[46]

39. The Manual of Air Traffic Service (MATS) 2.8.7 sets out specific requirements regarding controllers' responses to a RAM alert.[47] Relevantly they require that -

2.8.7.1 On receipt of a RAM alert, the controller must provide tracking advice where necessary.
2.8.7.2 Where the aircraft's route is a known deviation from the flight plan, the FDR route must be modified to reflect the aircraft's actual route.
2.8.7.3 When the extent of an aircraft's deviation from the route held in the FDR is not known, such as during weather deviations, the controller should acknowledge the alarm and only modify the FDR when positive tracking advice is received from the pilot.

40. A number of witnesses testified as to their interpretation of these requirements. Mr Butcher testified that "where necessary" referred to the controller's subjective assessment but did not persist with this construction during cross-examination.[48] Mr Beadle testified that "where necessary" meant where necessary for separation purposes, and/or sought to import the concept of "procedural navigation tolerance" from other general sections of MATS to qualify "where necessary".[49] These were creative but tortured interpretations which reflected poorly on his credit as a witness. In cross-examination Mr Beadle agreed that the expression "where necessary" included where necessary from the pilot's perspective.[50]

41. Mr Hodge,[51] Mr Carey,[52] Mr Curran,[53] and ultimately Mr Butcher,[54] all experienced air traffic controllers, gave evidence to the effect that to discharge the obligation to provide tracking advice where necessary required air traffic controllers to communicate with the pilot. Although, as at July 2004, MATS did not mandate communication with the pilot, in terms, it was the only effective way to ascertain if tracking advice was necessary. Thus, the weight of the evidence supports an interpretation of MATS 2.8.7.1 which sits comfortably with the plain words used, does not offend common sense and serves the interests of air safety.[55] Nor can it be sensibly argued that his assumption that TNP was still tracking to BLAED was supported by "positive tracking advice" as required by MATS 2.8.7.3.

42. Mr Carey's approach to addressing the RAM alert was to ascertain for himself the extent of TNP's deviation from track. By using the velocity vector and route function overlay he

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46 CB192.
47 Other sections of MATS which relate to general surveillance and the provision of a radar service (2.2.38 and 2.2.3.9) do not detract from these specific and relevant sections.
48 Compare T842 to T871-873.
49 T408-409.
50 See generally T506-520.
51 T215-220.
52 T349-352.
53 T1163
54 T871-873.
55 Mr Chew and Mr Hood, both experienced pilots, gave evidence that if they were flying in instrument meteorological conditions in controlled airspace and were 7.5 nautical miles off cleared track, they would expect to be advised of the fact by ATC-T625 and 1191 respectively. Mr Beadle thought such an expectation was unreasonable-T466-467.

assessed that the aircraft was tracking to BLAED.[56] However, this was a flawed approach as the route function simply connects the aircraft's current position to its last cleared waypoint or destination, and as any two points on a map can be connected by a straight line, it is a poor test of track deviation. A better use of available on screen tools would have been to overlay the bearing and range line over the velocity vector so as to extrapolate current heading and speed and ascertain where the aircraft would be in so many minutes time.[57] Although he did not think to use this tool at the time, Mr Carey agreed at inquest that this would have provided a better visual from which to gauge any deviation from cleared track.[58]

43. Mr Carey's approach also appears to overlook or give little weight to the fact that a RAM alert indicates by its very nature that there has been a 7.5 nautical mile deviation from cleared track which requires proper assessment and resolution, and appears to focus destination in disregard of the pilot's obligation to maintain track in accordance with his clearance and to obtain a new clearance in order to deviate from track.

44. A number of arguments were mounted on Mr Carey's behalf in justification of his resolution of the RAM alert, indeed both RAM alerts. Although Mr Carey did not know Mr Endicott personally, he was familiar with his work as a pilot and believed him to be competent.[59] He testified that he relied on this fact in support of his decision not to contact Mr Endicott regarding the RAM alert.[60] However, he was also aware of a pilot's fundamental obligation to maintain track and agreed that competent pilots do not normally deviate 7.5 nautical miles without an amended clearance.[61] While it may have been reasonable for Mr Carey to rely on Mr Endicott's competence as a pilot in other contexts, so long as pilots have human frailties and equipment may malfunction, he was not entitled to do so in performing his ATC role.

45. An attempt was made to characterise RAM alerts as something less than a real alert with safety consequences, but merely a controller advisory tool, requiring resolution so that TAAATS would continue to process the flight automatically. This characterisation is inconsistent with the configuration of TAAATS, the provisions of MATS and is against the weight of the evidence.[62] The related assertion that there may be false RAM alerts was never substantiated in evidence in terms of the nature of the alleged "falsity", nor was there any suggestion that the RAM alert/s in respect of TNP on 28 July 2004 were false.[63] Finally, the fact of an apparent hierarchy of alerts/alarms in MATS, while it may inform prioritisation in the event of two or more alerts, does

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56 T285 "I put the route function on the aircraft up, compared it to the velocity vector, and I put up the four minute velocity vector to be able to show a good comparison of his heading projected to the four minute time frame...To see how it compared to where he was cleared to - what point - waypoint he was cleared to. The route function and the velocity vector were either overlaying, or were in such a close proximity to overlaying that I could not see any reason to doubt that the aircraft at that point in time - as I was assessing it, was tracking to Echo Delta..."

57 T229-230, 361 and following.

58 T362.

59 T282-283.

60 T309, 342-344.

61 T341-2, 376-377. Mr Carey had some 120 hours VFR flight experience himself but had not flown for some 25 years. T318.

62 It seems obvious that the integrity of TAAATS requires accuracy of the FDR for purposes including "separation" of aircraft which is a paramount consideration. T260-62, 348, 415, 900, 1099-1100.

63 Were they in the nature of a computer glitch and not reflective of an actual deviation? Were they considered false in the sense of a nuisance alerts if an aircraft fortuitously regained track without assistance? T254, 357

not justify lesser treatment of a RAM alert in isolation.[64]

46. Although logically redundant, given my interpretation of MATS 2.8.7 above, reliance was placed on limitations in TAAATS which hampered his ability to ascertain the extent of track deviation, in particular the absence of a display of an aircraft's cleared track.[65] While such a display would have assisted in assessing a deviation, there were tools available which could have been used, perhaps more effectively than they were.

47. Reliance was also placed on the nature and extent of Mr Carey's workload as justification for his decision-making regarding the RAM alert/s. Clearly, TNP was one of about 7 aircraft under Mr Carey's control at the time and not his only focus. I accept that it was fundamental to his role as an air traffic controller that he maintain situational awareness of the whole sector. This involved the practice of continuously "scanning" the sector, and necessarily limited his observation of any one aircraft to a series of snapshots in time. However, the weight of evidence supports a finding that his workload was no more than moderate for an ATC.[66] Even accepting that the work of an ATC involves a high cognitive workload involved, as was clearly depicted in the replay/simulation,[67] and consistent with the weight of the evidence before me, the deviation from cleared track was consistently and progressively left of track or to the south, and apparent.[68] Moreover, TNP's deviation from cleared track to the extent of 7.5 nautical miles was inherent in activation of the RAM alert.

48. Mr Carey gave evidence in difficult circumstances, and did so in a candid and responsive manner. However, in resolving the RAM alert by re-routing TNP from its current position to BLAED without communicating with Mr Endicott about track deviation, he exercised poor judgement and did not comply with his obligations under MATS 2.8.7.1 and 2.8.7.3. In so doing, he contributed to the accident as there was a lost opportunity for avoidance of the accident.

THE SECOND RAM ALERT @ 10.42.17am

49. In the course of its descent, TNP descended through 8,500 feet leaving controlled airspace at about 10.40am. Mr Carey testified that shortly after this time but before the RAM alert @ 10.52.17 he determined that TNP was tracking to the southern GPS waypoint for Benalla Airport BLAEG. He used the bearing and range line by anchoring it to BLAEG and extending it to TNP, its velocity vector and the short history tail behind it.[69] This involved a difficult comparison of small angles. Had Mr Carey used the bearing and range line in reverse, that is anchored to the velocity vector and short history tail behind TNP and extrapolating forward, the significance of the deviation, even from BLAEG would have been more apparent.

50. In the witness box, Mr Carey undertook a comparable exercise in extending TNP's radar track from about 10.42am demonstrating that TNP would pass about four miles south of even the southern waypoint BLAEG, and agreed that extending the velocity vector and short history tail

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64 T211, 338, 1167

65 See comments section below - as part of ASA response to this accident and its internal investigation, TAAATS was enhanced to display an aircraft's clear route.

66 T285, 899, 986, 1161. Note also that ATCs are rostered for a maximum of 2 hours, in recognition of their high cognitive workload.

67 See footnote 5 above. It should be stressed that while attachment 1 is a convenient graphic depiction of the extent of deviation, it is a significantly different display than that on the ATCs' ASD or screen

68 T 290.

69 T290-291.

on his screen at the time would have been to the same effect. He testified that he would have contacted the pilot if he had made this observation at the time.[70]

51. When the RAM alert activated at 10.42.17am, consistent with his assessment that the aircraft was tracking to BLAEG, Mr Carey re-routed TNP to BLAEG thus amending the FDR in TAAATS and establishing a new RAM corridor for TNP. According to his evidence, he recognised that the RAM alert indicated a 7.5 nautical mile "significant" deviation from cleared track, which was to BLAED at the time, and also acted on his belief that the pilot had decided to track to the southern rather than the northern waypoint. When cross-examined, he agreed that the element of guesswork in his reasoning could have been overcome by contacting the pilot.[71]

52. At 10.45.07am Mr Endicott advised Mr Carey that he was commencing his GPS approach in the following terms "Melbourne Centre Tango November Papa is commencing GPS approach at Benalla changing to one two decimal five and we'll call again at time five five".[72] Significantly, neither Mr Endicott, nor Mr Carey when he routinely acknowledged, referred to the specific waypoint at Benalla, and Mr Carey did not take this opportunity to alert the pilot to his deviation from track and/or to test his assumption that TNP was heading to BLAEG.

53. Aside from the discussion relevant to the first RAM alert above, three additional issues arose in relation to the second RAM alert - the compounding effect of a second deviation left of track, the fact that aircraft was outside controlled airspace, and the concept of confirmation bias.

54. Both the ATSB investigation and the ASA internal investigation concluded that the progressive deviation to the left/south of track was significant as at the second RAM alert as, being a deviation in the same direction it had a compounding effect.[73] Mr Butcher (ASA) agreed that the pilot should have been advised of the significant deviation from track at this time.[74] Mr Hood (ATSB) echoed the findings of his investigation by testifying that both alerts required resolution with the pilot.[75] Mr Sullivan unconvincingly sought to recast this aspect of the ATSB report.[76]

55. There was an attempt to limit the operation of the MATS requirements regarding RAM alerts to controlled airspace alone. On their face, the requirements apply to aircraft whether in controlled or in uncontrolled airspace. At inquest, Mr Beadle, Mr Butcher, Mr Sullivan and Mr Curran all agreed with this interpretation.[77]

56. The concept of "confirmation bias" as it may have operated on Mr Carey in relation to his resolution of the second RAM alert, in particular, was based on Dr Hannan's evidence[78] of this phenomenon of human cognition which operates at the subconscious level, allowing people to prefer evidence consistent with their initial hypothesis and disregard evidence tending to another conclusion. Dr Hannan was a psychologist with a sound understanding of the work demands on air traffic controllers and familiarity with TAAATS. The possibility that confirmation bias may

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70 T363-364, 370.
71 T375-375. Note the additional MATS requirements for general surveillance and providing a radar service in 2.2.3.8 and 2.2.3.9.
72 CB214.
73 CB130,135, 224, 233.
74 T806-807.
75 T1191.
76 T998-994, 1005-1006, 1021-1023.
77 T506-507, 870, 1014,1163.
78 Exhibit 15 was Dr Hannan's expert report which included his formal qualifications and experience.

have influenced Mr Carey was acknowledged in the ASA internal investigation report, the ATSB investigation report and also by Mr Curran in evidence.[79] Allowing that confirmation bias may have influenced Mr Carey's decision-making around resolution of the RAM alerts, and that it is a matter which may mitigate or exculpate in another forum, it does not impact on the consequences of his decision-making and its contribution to the accident.

57. I find that in resolving the second RAM alert by re-routing TNP from its current position to BLAEG without communicating with Mr Endicott about track deviation, he exercised poor judgement and did not comply with his obligations under MATS 2.8.7.1 and 2.8.7.3. In so doing, he contributed to the accident and another opportunity for avoidance of the accident was lost.

WAS THERE ANY INTERRUPTION TO GPS COVERAGE AND/OR DID THE TRIMBLE OPERATE IN SUCH A WAY AS TO CAUSE OR CONTRIBUTE TO THE ACCIDENT?

58. This was not a case of any problem with satellite signals, in the sense of satellites dropping out of the GPS system, nor of any mobile phone interference with the GPS receiver in TNP. The unchallenged evidence before me was that satellite signals were normal on 28 July 2004.[80]

59. The idea that some manner of GPS failure caused or contributed to the accident, can be understood in broad terms from **attachment 2** which graphically illustrates the correspondence, and transposition to the south east, between the track which would have been flown in approaching Benalla Airport from the north-east where operations were normal and the track actually flown as evidenced by radar date and witness sightings.

60. More specifically, the following facts are established and have to be accommodated by any explanation for the cause of this accident -

- Mr Endicott's call at 10.45am that he was commencing a GPS approach
- the last clearance issued by ATC to TNP was to waypoint BLAED
- the aircraft's undercarriage was extended and the flap set for landing
- the aircraft's flight level was 5,100 feet, consistent with 5,000 feet being the prescribed flight level for commencement of a GPS approach from BLAED[81]
- the radar identified a turn to the south south west at this time, consistent with the turn required at BLAED to track to the next waypoint BLAEI[82] and
- the fact that the aircraft collided with terrain at about 1,052 leaving a swathe through foliage for about 200 metres on a bearing of 258 degree magnetic.

61. The weight of the evidence supports a finding that Mr Endicott believed that operations were normal and that he was conducting a GPS approach to Benalla via waypoint BLAED in accordance with his clearance. The only reasonable inference is that the GPS on which he was relying in IMC conditions was giving him sufficient indications of normality to assuage any concerns arising from other messages or information on his flight instrumentation.

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79 There was also evidence that ASA are aware of the risks of confirmation bias and address it in their ongoing training of air traffic controllers.

80 CB271-272, 278.

81 Attachment 3 "Benalla Runway 26L GPS instrument approach chart."

82 Attachment 2 and Attachment 3.

62. Mr John Chew, an independent expert pilot, provided a report in which he developed a hypothesis that the above facts indicated that the Trimble was in dead reckoning or DR mode.[83] He explained that the Trimble could go into DR mode when it was not receiving satellite signals. Although there was no interference with satellite signals on 28 July 2004, the Trimble could also go into DR mode if the signal was being received by the aircraft's antenna, but not being received by the Trimble GPS unit in the cockpit. Once in DR mode the Trimble would continue to apply and display the last ground speed and the heading being flown at the time it defaulted to DR mode.

63. Mr James MacDonald, a licensed aircraft maintenance engineer specialising in avionics and a licensed pilot testified at inquest. He described the likelihood of the aerial disconnecting from the Trimble unit in the cockpit as fairly slim. However, he also testified about a number of scenarios which might cause interference between the aerial and the Trimble unit of a type which could cause it to default DR mode, some involving the display of a fault message, others going straight to DR mode.[84] He also produced a degraded aerial at inquest by way of illustration.[85]

64. By way of illustration of his hypothesis, Mr Chew flew several flights which were video recorded for use at the inquest. Flights numbered 2, 3 and 4 demonstrated the Trimble in DR mode after he had interfered with the unit so as to simulate DR mode. Significantly, the user manual for the Trimble did not advise of the existence of this feature.[86] Nor did the initial ATSB investigation which relied on the accuracy of that manual, address this possibility.[87]

65. At the inquest, Mr Chew expressed the view that it was highly probable that Mr Endicott believed he was at BLAED at 10.45am. The logical basis for that belief had to be that the Trimble showed that the aircraft was at BLAED, that the course deviation indicator (CDI) was centred indicating adherence to track, that the distance was reading down either to BLAED or BLAEI as the next waypoint, consistent with the approach to Benalla Airport,[88] and that Mr Endicott had a belief based on his scan of the flight instrumentation, which did not challenge that belief. Mr Chew was cross-examined at length about the unlikelihood that Mr Endicott could have disregarded a number of messages and indications on flight instrumentation which should have alerted him to a GPS problem or that operations were not normal.[89]

66. Mr Hood testified that Mr Chew's hypothesis was plausible but that he had some reservations about the nature of the message lights and indications on flight instrumentation, and the unlikelihood that an experienced pilot would either not see or not heed these. He agreed that at 10.45am the pilot was receiving information from the Trimble on which he was relying for the approach and that no other avionics could have given him this assurance. Since the aircraft was some 15 nautical miles from BLAED and 13 nautical miles from BLAEG at the time, he could not suggest an alternative scenario or type of GPS malfunction apart from DR mode as described by Mr Chew.[90]

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83 CB242 and following.
84 CB266, T718 and following.
85 Exhibit 10.
86 CB249
87 Mr Ballard's evidence at T and the ATSB investigation report CB.
88 T628.
89 T628. He also made a number of calculations attempting to identify the point in time when the GPS unit would have gone into DR mode by extrapolating forward to the position of TNP at the commencement of its approach.
90 T1207-1208, 1194. Mr Hood also provided additional evidence about an incident referred to in the ATSB investigation report (CB230) involving a Dash 8 aircraft fitted with a Trimble which gave erroneous position information and bore some similarities to the case in point. T1189, 1208.

67. Mr Ballard was an aeronautical engineer from the ATSB who testified at inquest. He had preliminary reservations regarding Mr Chew's hypothesis on the basis of his own bench test simulation of DR mode, radar data and oscillations in TNP's flight path which he identified as inconsistent with the hypothesis, and calculations on which he posited a different descent point and time in relation to BLAED.[91] He also outlined in some detail the instruments which could have given Mr Endicott contrary information to the GPS but conceded that their precise configuration and inter-connections were not known.[92] Mr Ballard could not point to any other cohesive explanation of the series of facts pertaining at 10.45am.

68. The preliminary reservations articulated by Mr Ballard at inquest firmed, after further investigation, to represent the ATSB's final view to the effect that navigation in GPS DR mode was a possible but improbable explanation for the accident. Improbable, due to inconsistencies between the recorded radar data and the principles of navigation in DR mode, and the inherent unlikelihood that Mr Endicott would not notice a range of messages and warnings on the GPS unit itself, annunciator lights or pictorial navigation indicator. The ATSB found a fault with the aircraft's navigation or autoflight systems, a mis-selection of those systems by the pilot or some combination of both factors more probable. [93]

69. Although, for present purposes, I have referred generally to messages, warnings and flight instrument information which might have been inconsistent with GPS information and alerted Mr Endicott to a problem with the GPS, the evidence does not enable me to make a finding as to when those messages, warnings or inconsistent information appeared and what substantive information they were conveying.[94]

70. Mr Chew's hypothesis was tested in detail during cross-examination. As reflected above, the broad challenge was based on the unlikelihood that Mr Endicott would have ignored messages or parameters indicated by other equipment in the cockpit which would have been inconsistent with information on the GPS and should have alerted him to a problem. Mr Chew's unchallenged evidence about the extent to which pilot's relied on the accuracy of GPS as an accurate instrument, is of relevance in this regard.[95] As is his evidence that pilot's priorities are to "aviate, navigate, communicate" in that order, and that Mr Endicott's main focus in conducting an approach in IMC would have been the information on the GPS.

CONCLUSION

71. The standard of proof for coronial findings is the civil standard of proof on the balance of probabilities with the *Briginshaw* gloss or explication.[96] The effect of the authorities is to require the coroner to consider the seriousness of the matters alleged and the consequences of an

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91 T1260 and following.

92 T1235, esp at 1242 and following.

93 Paraphrasing the findings of the ATSB final report dated February 2009 pages 57-58.(ATSB report 200402797).

94 Evidence of Mr Chew, Mr Macdonald, Mr Hood and Mr Ballard.

95 T602.

96 *"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 issue has 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..."* Briginshaw *v* Briginshaw *(1938) 60 CLR 336 esp 362-363.*

adverse finding for any person, in reaching a reasonable satisfaction that a matter is proven.[97] I have applied that standard to the totality of the evidence before me in order to make findings about the contentious aspects of the circumstances.

72. In trying to ascertain the cause of this accident, we are already in the realm of the improbable, in the epidemiological sense. Mr Endicott was an appropriately qualified and experienced pilot flying a familiar route in a well-equipped, well-maintained aircraft with which he was familiar. A number of witnesses expressed the opinion that he was unlikely to have ignored messages, warnings or other indications that there may be a problem with the GPS. And yet this accident occurred.

73. Mr Endicott was flying in cloud with no visual cues that he was flying off track and/or into terrain. He was commencing an approach relying on GPS and no land-based navigational aids. It is reasonable to infer that he believed that operations were normal and that in "scanning" the array of instruments before him he focused on information from the GPS unit. Some other instruments are likely to have given him comfort that operations were normal, others if scrutinised, are likely to have given him concern. Earlier deviations from track had not been brought to his attention and it is reasonable to infer that he was not otherwise alert to or investigating a problem with the GPS. He may have been influenced by "confirmation bias" in seeing only what he wanted to see[98] and may have been distracted by the presence of other pilots.[99] He may have realised that there was an inconsistency and simply preferenced the GPS information, or he may have even realised there was a fault with the GPS but not in time to take any effective evasive action.

74. Mr Chew's hypothesis that the Trimble GPS was in DR mode by the time Mr Endicott announced commencement of a GPS approach to Benalla Airport at 10.45am provides an elegant, if imperfect, fit with the known circumstances. Taking all evidence before me into account, I find that the accident which took the lives of all six deceased was caused by navigation with the Trimble GPS in DR mode.

COMMENTS:

Pursuant to section 67(3) of the **Coroners Act 2008**, I make the following comment(s) connected with the death (including any notification to the Director of Public Prosecutions under Section 69(2) of that Act):

1. The internal investigation conducted by Air Services Australia concluded with 7 recommendations. I was appraised during the inquest of measures taken to address the 6 recommendations within the province of ASA. In particular, as at the time of the inquest the Australian Advanced Air Safety System (TAAATS) had been enhanced with a graphic tool which readily displays an aircraft's cleared route as recorded on the flight data record, on the controller's screen, and the Manual of Air Traffic Services (MATS) had been amended to mandate communication with a pilot in order to resolve a RAM alert. ASA are to be commended for having addressed these recommendations which provide greater clarity and guidance to controllers and should improve air safety.

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97 *Re State Coroner; ex parte Minister for Health (2009) 261 ALR 152 AT [21]*
Anderson v Blashki [1993] 2 VR 89 at 95
Secretary to the Department of Health & Community Services v Gurvich [1995] 2 VR 69 at 73-74

98 Exhibit 15 paragraph 17, T945-951.

99 CB258, T640.

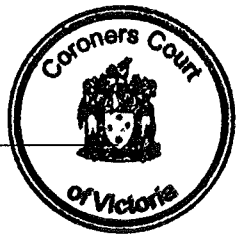
2. Despite not finding navigation in dead reckoning mode a probable cause of the accident, the Australian Transport Safety Bureau issued a safety advisory notice regarding dead reckoning navigation, recommending that users of GPS navigation receivers should note this safety issue and take appropriate action to ensure familiarity with dead-reckoning operation and any associated receiver-generated warning messages. ATSB are to be commended for taking this action and I would reinforce the necessity for pilots to be aware of this important safety issue.

3. This is yet another "controlled flight into terrain" and highlights the need to improve air safety by revisiting the prevention of such accidents. During the inquest I was advised that TAAATS could be enhanced to incorporate a Minimum Safe Altitude Warning which would activate when aircraft were at risk of breaching their minimum safe altitude, but that this would involve significant expense, reconfiguration of airspace and other logistical difficulties. This was a position urged in particular by Mr Anderson on behalf of the Henderson family.

4. An alternative approach, supported both by Mr Harvey on behalf of ASA and Mr Livermore on behalf of the ATSB was to consider Terrain Awareness and Warning Systems (TAWS) which were not a legal requirement to be fitted in aircraft such as TNP at the time. They were however required to be fitted (by 30 June 2005) to all turbine aircraft with a capacity to carry 9 or more passengers, or with a weight of 5,7000 kgs or more. Again this does not encompass TNP. Had TNP been equipped with such a system with a predictive or forward looking terrain avoidance function, this accident may well have been prevented.

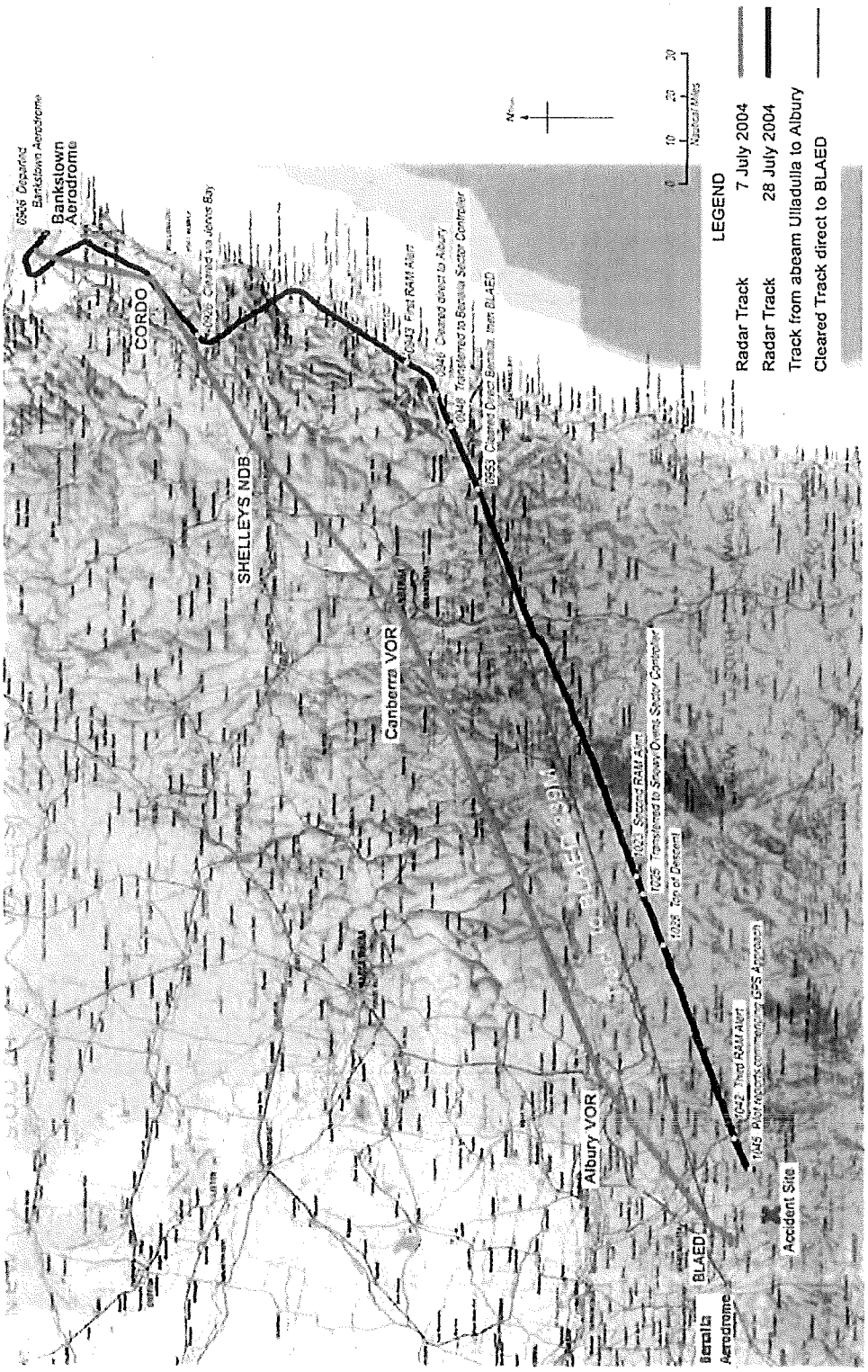
5. But for a reading of section 72(2) of the Coroners Act 2008 which does not encompass federal Ministers, public statutory authorities or entities, I would have couched Comment 4 in terms of a recommendation that the Civil Aviation Safety Authority reconsider the introduction of a requirement that aircraft with a passenger capacity such as TNP be fitted with a Terrain Awareness and Warning System.

Signature:



PARESA ANTONIADIS SPANOS
CORONER
Date: 30 September, 2011

ATTACMENT 1


Bankstown Aerodrome
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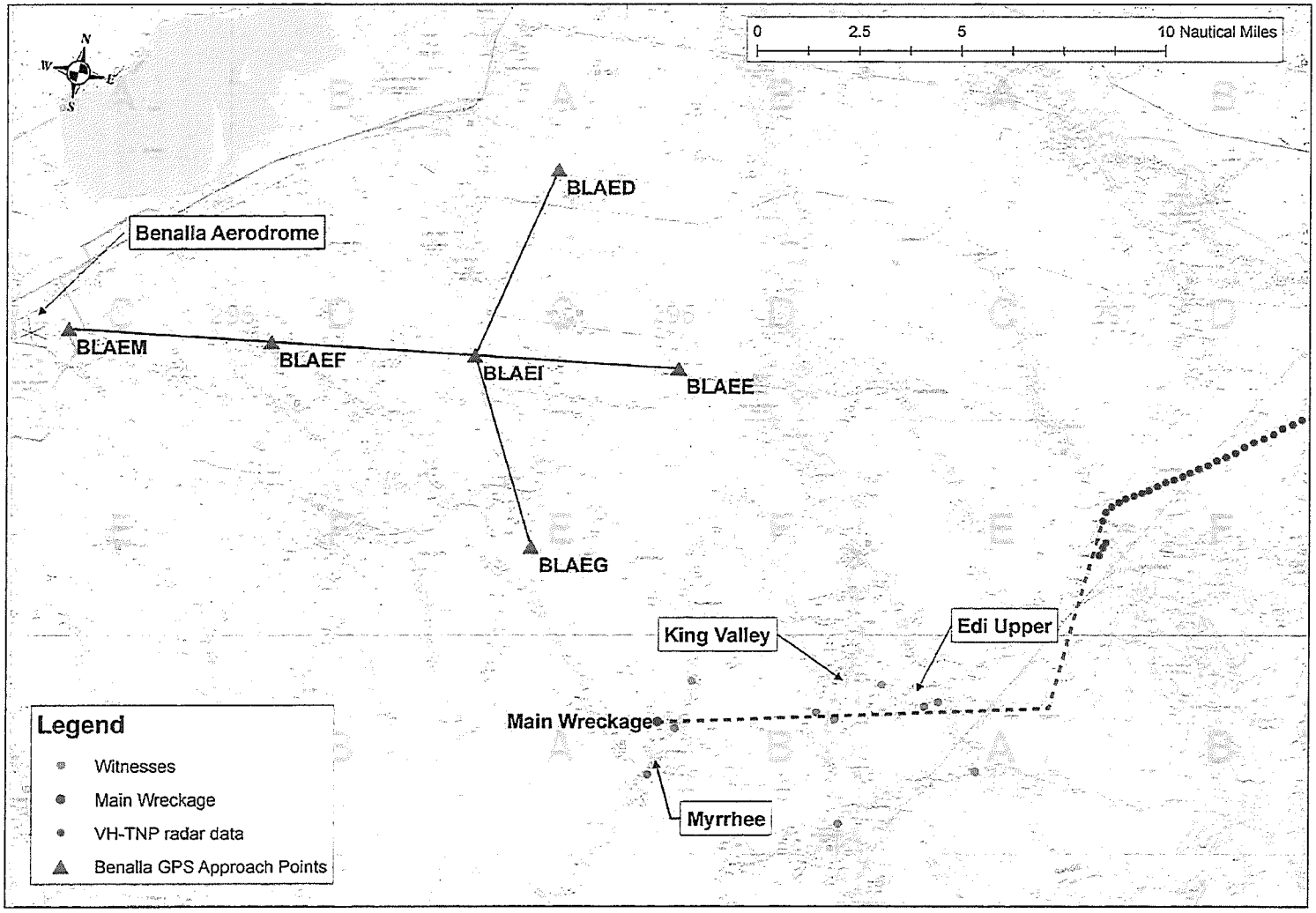
CORDO
SHELLEYS NDB
Canberra VOR
Albury VOR
BLAED
Bendalla Aerodrome
Accident Site
LEGEND
Radar Track 7 July 2004
Radar Track 28 July 2004
Track from abeam Ulladulla to Albury
Cleared Track direct to BLAED
Nautical Miles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10 Nautical Miles
Benalla Aerodrome
BLAED
BLAEM
BLAEF
BLAEI
BLAEE
BLAEG
King Valley
Edi Upper
Main Wreckage
Myrrhee
Legend
Witnesses
Main Wreckage
VH-TNP radar data
Benalla GPS Approach Points

ATTACMENT 2

ATTACMENT 3

Figure 13: Benalla Runway 26L GPS instrument approach chart