OFFICE OF THE STATE CORONER

FINDING OF INQUEST

CITATION:	**Inquest into the Helicopter Crash near Gunpowder**
TITLE OF COURT:	**Coroner's Court**
JURISDICTION:	Brisbane
FILE NO(s):	Various
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FINDINGS OF:	Mr Michael Barnes, State Coroner
CATCHWORDS:	**CORONERS: Inquest, helicopter accident, Chief Pilots supervision of Line Pilots, CASA's acceptance and audit of AOC holders operations manuals**

REPRESENTATION:

Counsel Assisting:	Mr Ian Harvey
North Australian Helicopters:	Mr John Ribbands (instructed by Maitland Lawyers)
Civil Aviation Safety Authority:	Mr Joe Rule (instructed by CASA Legal department)
Australian Transport Safety Bureau:	Mr Nevin Agnew (Minter Ellison Lawyers)

A copy of the findings of a coroner's inquest must be given to the family of the person who died; each of the persons or organizations granted leave to appear at the inquest; and to officials with responsibility for any activities that are the subject of any recommendations.[1] These are my findings in relation to the death of those who died in the Gunpowder helicopter crash. They will be distributed in accordance with the requirements of the Act and posted on the website of the Office of the State Coroner.

Introduction

On 21 February 2006, mining technicians in a helicopter were surveying possible routes for electricity transmission lines and a water pipeline as part of study of the feasibility of developing a copper processing plant on a large mining tenement in the vicinity of Mount Gordon, approximately 100 kilometres north west of Mount Isa.

At 1:41pm, after refuelling, the aircraft took off from a remote airstrip with the pilot and three passengers on board. When the helicopter did not arrive at a rendezvous point a couple of hours later, the ground crew hoped those on board had made other plans. However, when darkness fell and nothing had been heard from them, Australian Search and Rescue, AusSAR, part of the Rescue Coordination Centre (RCC) in Canberra, was contacted and a search commenced. At 11:15am the next morning, the burnt wreckage of the helicopter was located approximately 10 kilometres from the airstrip. It was immediately apparent none of those on board had survived.

These findings confirm the identity of those killed in the crash, the medical cause and time and place of their deaths. They also seek to establish the cause of the crash and consider:-

- Whether the systems within the operating company North Australian Helicopters Pty Ltd (NAH) were sufficient to ensure its pilots were fully equipped to make necessary calculations (both in preparations for the undertaking of a series of aerial surveys and in the field) of the in-flight performance of the R44 helicopters used in such surveys in harsh or changing meteorological conditions;

- Whether NAH provided sufficient guidance and support through its Chief Pilot for all aspects of pre-flight planning of aerial surveys that Ms Stott was required to undertake;

- The extent to which CASA, in accepting the operations manual of NAH and otherwise conducting surveillance of NAH's operations, could effect compliance with the helicopter manufacturer's safety notices and pilot operating manual.

[1] *Coroners Act 2003* s45 and s46

The investigation

At about 8.00pm on 21 February 2006, Mt Isa police were notified by the managing director of NAH, Mr John Logan that the helicopter was over-due and the pilot had not been heard from. A major incident room was immediately set up and an investigation team assembled. Sergeant Chris Smith, a qualified and experienced crash investigator was appointed lead investigator.

The QPS officers liaised with the search authorities from the AusSAR. Search coordination was commenced by AusSAR and the QPS officers commenced gathering details about the people on board and contacting cattle stations surrounding the area in which the aircraft had been operating to ascertain whether it had been seen or heard. The ATSB was also notified and the QPS disaster victim identification squad was put on stand by.

When the wreckage was located, an officer from a Queensland Search and Rescue helicopter was winched down to look for survivors. He confirmed four dead. QPS scenes of crime officers and crash investigators were on site by 15.30 on 22 February and the scene was secured.

The next day, a forensic pathologist and a mortuary technician joined DVI officers at the scene. The bodies of the pilot and three passengers were retrieved from the wreckage and flown to Brisbane for autopsy.

Four ATSB officers arrived at the scene at about 1.30pm on Thursday 23 February. Control of the site then passed to those officers.

The ATSB made a detailed examination of the wreckage and the surrounds. Photographs were taken and the engine and other parts of the aircraft were removed for further examination.

Data from one of the GPS instruments used during the operation were recovered and analysed by the ATSB to identify the movements of the aircraft on 21 February 2006. From these data the ATSB sought to extract the flight times of the various sorties flown by VH-HBS on the day of the crash. It also attempted to plot the track of the final flight. While these data are of assistance, they have limitations. For example, the flight times do not provide any estimation of ground running time, the GPS plots only horizontal tracking and records the position of the aircraft at irregular intervals, thus giving no information about its position in between these points. As result, the actual speed and direction of travel at a particular point can not be accurately calculated. It just shows the latitude and longitude of the helicopter at recorded times, with little information about variations in speed or direction in between those plotted points.

The ATSB's technical analysis of the pre-crash airworthiness of the helicopter was obviously hampered by the extent of destruction of the aircraft both through impact damage and fire. However, for the reasons I will detail later, the Bureau concluded it was unlikely engine failure contributed to the crash.

On 23 February 2006, the ATSB faxed a Protection Order to NAH requiring it not to move or interfere with the *"Fuel drums used to fuel the helicopter at Mt Gordon airstrip on 21 February 2006."* However, the facsimile cover sheet advised the NAH's chief pilot to *"quarantine at least one sealed drum of the* ***same batch of drum stock*** *used to fuel the helicopter."* As will be detailed later, it seems some lack of rigor around control of the drums used to fuel the helicopter at Gunpowder led to some confusion and possibly mistakes in identifying the drums in question.

In the course of its investigation, the ATSB interviewed members of the survey team who had flown in the aircraft on the Tuesday morning prior to accident flight, as did the police investigators.

The ATSB accessed Bureau of Meteorology information to determine the weather conditions in the vicinity of the accident site in the afternoon of 21 February 2006.

Notwithstanding the concerns about control of the fuel drums used at Gunpowder, I am satisfied the crash was effectively investigated by both the QPS and the ATSB. Both agencies are to be commended. The DVI squad also operated effectively in difficult conditions. The deployment of a forensic pathologist and mortuary staff on site was a useful development in the disaster response.

Background

In early 2006, CopperCo Limited was investigating the feasibility of developing a copper processing plant at the site of an abandoned mine at Mount Kelly in a remote and rugged area north-west of Mount Isa. For this purpose, CopperCo engaged a project management company, Ausenco Limited, to bring together a team of engineers and other specialists to identify a route for a pipeline and power line between an existing facility at Mount Gordon and the proposed copper processing site at Mount Kelly, a distance of some 40 km.

The members of the survey team were:

- Mr Paul Carl Bielenberg, a surveyor and a director of MH Lodewyk Pty Ltd
- Mr Travis Drysdale – an Ausenco project engineer
- Mr Robert Ellis – the Ausenco project manager
- Mr Thomas William Lancaster – a CopperCo manager
- Mr Derek Victor Powell – an environmental scientist from Klohn Crippen, an engineering and environmental consulting firm
- Mr John Smit – a mechanical engineer and a director of JDS Support Services Pty Ltd
- Mr Andrew Wiklund – a transmission engineer and a director of an electrical engineering company, PLD Consulting Pty Ltd .

To assist with the survey, CopperCo chartered a four seat, Robinson R44 helicopter, VH-HBS, from NAH; a Katherine based company that also operates in Mount Isa. NAH held an air operator's certificate (**AOC**)

authorising it to conduct charter and aerial work operations in a range of helicopters. The aircraft was to be flown by an employee of NAH, Ms Vita Stott. As she was at the controls when the helicopter crashed it is appropriate at this point to outline Ms Stott's qualifications and experience and relevant details of the aircraft.

The pilot

Ms Stott was trained at Becker Helicopters on the Sunshine Coast and was issued a commercial pilot (helicopter) licence in May 2005. That month she also completed a R44 helicopter endorsement and low flying training. In addition to the basic commercial training Ms Stott was required to do to obtain her commercial licence; she also undertook a number of other advanced flying courses. The principal of the flying school held her competence and attitude to safety in very high regard. He said she had extensive training in recovering from low RPM situations and controlling the aircraft in autorotation.

In July 2005, Ms Stott commenced employment with NAH, based primarily at Mt Isa. NAH's Chief Pilot, Mr John Logan, conducted a check flight with Ms Stott and considered that she was a "*safe and competent*" pilot.

From July 2005 to October 2005, Ms Stott was primarily engaged in ferrying helicopters and joy flight operations.

On or about 9 October 2005 she left her employment with NAH to travel back to Scotland and until 19 December 2005 it appears that she undertook no flying. She returned to Australia in December 2005 and was re-employed by NAH following a refresher flight with her former flight instructor, Mike Becker. It was only in the month preceding the accident that she commenced undertaking survey flying operations for NAH.

By the time of the accident, Ms Stott had flown some 330 hours on rotary wing aircraft of which 144 hrs had been spent on the R44 helicopter. She had only 214 hours flying as pilot in command. She had flown some survey flights in the six weeks after she rejoined NAH. On any measure she was an inexperienced commercial pilot.

The aircraft

The incident helicopter was manufactured in the U.S. in 1997 and entered onto the Australian register that year. It had operated for 2,652 hours at the time of the crash. The aircraft's Lycoming six cylinder normally aspirated piston engine was overhauled in June 2004, before being fitted to VH –HBS, and had been operated for 656 hours in that aircraft. Since that time all scheduled maintenance had been undertaken. Since its last 100 hourly inspection the aircraft had operated for 30 hours.

Preparations

The surveyor, Mr Bielenberg, was the only member of the survey team who lived locally. On the afternoon of Sunday 19 February he met with Mr Logan and Ms Stott to prepare for the aerial aspect of the survey. That involved

discussion of the routes to be flown, the embarkation and disembarkation of passengers and other logistical matters. It was proposed to use a small unmanned airstrip at Gunpowder for refuelling the aircraft.

Mr Bielenberg provided Ms Stott with a number of GPS waypoints for programming into the Garmin GPS III Pilot navigation unit that was to be clipped to top of the instrument panel in the helicopter to be used for the survey.

On Monday 20 February 2006, the rest of the survey team travelled to Mt Isa from Brisbane on a commercial flight. They were met by Mr Bielenberg. It was decided the team, other than Mr Bielenberg, would drive to the Gunpowder airfield on the Monday with two 200 litre drums of aviation fuel. The fuel would be left at the Gunpowder airfield and the team would travel on to the Mt Gordon mine site where all would stay overnight. Mr Bielenberg was to travel to Gunpowder in the helicopter on the Tuesday morning.

In accordance with this plan, the team set off from Mt Isa in the early afternoon of 20 February using three motor vehicles to travel to Gunpowder airfield with the drums of fuel on board one of the vehicles. The journey took about 2 ½ hours. After leaving the fuel at the airfield, the survey team continued to Mt Gordon.

That same afternoon Mr Logan assisted Ms Stott to push the helicopter out of the hangar and VH-HBS was fuelled with full tanks and the mandated daily inspection undertaken in preparation for the next morning's departure.

Early the next morning, in preparation for the day's flight, the pilot would also have been expected to do a series of "*engine run – up checks*" which included ensuring a dashboard light illuminated and a horn sounded when the main rotor RPM was allowed to drop below 97 on the main rotor side of the aircraft's tachometer. Mr Logan was confident Ms Stott would have performed these checks but as he not been at the hangar when she was preparing for the flight he could not be certain she did so.

Mr Logan says it was his practice to always remind his pilots about the need for caution as weather conditions changed throughout the day but he candidly acknowledged that he could not say exactly what reminders or warnings he gave Ms Stott on this day.

Mr Bielenberg arrived soon after 6.00 am and VH-HBS departed from Mount Isa aerodrome at about 06.23. [2] It seems likely the helicopter departed with 185 litres of usable fuel on board.[3]

[2] The times are as revised by the ASTB in exhibit D24

[3] The US FAA Type Certificate Data Sheet for the R44 helicopter shows that it has a main fuel tank with a usable fuel capacity of 30.6 US galls and an auxiliary tank with a usable fuel capacity of 18.3 US galls being a total of 48.9 galls which converts (1 US gall = 3.7854 litres) to 185.11 litres.

The survey commences

The trip to Gunpowder involved 28 minutes flying time and Ms Stott and Mr Bielenberg arrived at the airfield shortly before 7.00 am. There they met up with Messrs Smit and Wiklund.

Ms Stott briefed the passengers on matters relating to their travel on board the helicopter - they were warned to keep away from the rotors etc. Mr Smit sat in the left hand front seat with Mr Wiklund behind him in the rear left seat. Mr Bielenberg took up a position in the rear right side seat behind the pilot. There were no scales available for Ms Stott to weigh any passenger and it appears from the evidence of the survey team members who attended the inquest that they were not asked about their weight. The helicopter then departed Gunpowder airstrip on the first aerial survey flight of the day.

The data recovered from the helicopter's Garmin GPS III Pilot navigation unit, shows this flight commenced at about 7.03 am, involved 55 minutes of flying time and concluded back at Gunpowder airstrip at about 8.00am. This is confirmed by Mr Wiklund's evidence as to the time taken for the first flight.

Ms Stott then refuelled the helicopter – it seems with Mr Bielenberg's assistance. It then departed on the second aerial survey flight, this time with Messrs Bielenberg, Smit and Powell on board with Ms Stott. The GPS recovered data shows that the helicopter departed at 8.37am.

At about 9.15am they landed at a pre-arranged location known as "*the causeway*", near Mt Gordon where they met the others in the survey team who had driven there. The aircraft was on the ground for about 6 minutes. Before they took off, Mr Wiklund replaced Mr Powell in the aircraft. The helicopter then continued on the second aerial survey flight before returning to Gunpowder airstrip at about 10.41am.

Mr Wiklund assisted Ms Stott to again refuel VH-HBS. He says in his statement taken the day after the crash that he held the nozzle in the fuel tank while Ms Stott pumped fuel from a drum. He observed that the fuel was to the top of the first tank and repeated the process for the second tank. Ms Stott then replaced the caps on the fuel tanks. He gave a different version at the inquest but his previous version wasn't put to him. I have no reason to prefer the later version over the earlier having regard to the lapse of time before it was received and the somewhat confusing way in which he was questioned at the inquest. Against this conclusion is the statement of Mr Smit in which he said "*at about 10.30am, we returned to Mt Gordon airstrip where Paul and the pilot refuelled the helicopter".*

Messrs Ellis, Lancaster, Powell and Drysdale were undertaking ground survey activities during the morning and were not at Gunpowder airstrip when the helicopter returned after completing the second survey flight.

While at Gunpowder airstrip during this mid-morning stopover, Ms Stott used a satellite phone to call Mr Logan in accordance with the operator's standard procedures. The reception was poor and the phone "dropped out" but Mr

Logan gave evidence the pilot was able to confirm that everything was going to plan and no problems had arisen. Mr Wiklund estimated that, at this time, a south easterly wind was blowing at about 15 knots.

The helicopter departed Gunpowder airstrip on the third aerial survey flight with Messrs Bielenberg, Smit and Wiklund on board with Ms Stott. The GPS recovered data shows that the helicopter departed at 11.09am and returned to the airfield at 12.48pm.

The witnesses recall that on occasions the pilot had orbited the aircraft to allow observation of ground features. At other times she hovered over ground features to enable the recording of waypoints in a hand-held GPS used by the survey party.

Mr Smit said in evidence that during one of the morning flights, he noticed a yellow warning light flash on the right hand side of the instrument panel but he could not at the time of the inquest recall the exact position of the light on the panel. He did not think it was the light on the far end of the panel; but possibly the light one or two from the right end of the panel.[4] This differs from the evidence gathered by the ATSB in which one of the passengers, presumably Mr Smit, told their investigator the light which illuminated was in the position of the low RPM warning light – "*The passenger was able to confirm the name, the colour and position of the light*…". In his police statement taken the day after the crash he said; *"I think it related to low RPM or something similar*..." At the time, the helicopter was hovering and the pilot commented the light was nothing to worry about as they were in a "*hovering pattern"*. NAH seeks to discount that remark by suggesting it is a term that is "*meaningless to other pilots.*" Be that as it may, it is a term that appears in Ms Stott's log book on a number of occasions. I therefore accept Mr Smit's evidence that it was said and conclude that Ms Stott was indicating that the light in question illuminated because the aircraft was hovering.

In none of the versions did the witness report an aural alarm or horn sounding as should have occurred if the RPM of the main rotor fell below a safe level.

Mr Wiklund said in evidence that during the flights that he was on in the morning, he observed Mr Bielenberg with a GPS unit which had a number of different routes and waypoints programmed into it. Initially Mr Bielenberg attempted to use the GPS readings to tell the pilot, Ms Stott, what heading or direction to fly. According to Mr Wiklund that was not working too well and so Mr Bielenberg gave the GPS unit to Ms Stott. Thereafter she flew with the GPS unit resting in her lap. She would glance at it to determine her heading and then look up and continue to fly. On occasions, however, it was necessary for Ms Stott to hand the GPS unit back to Mr Bielenberg for him to program a waypoint into the GPS unit or access the next route before handing it back to Ms Stott.

[4] There are places for 8 warning lights on the instrument panel of the R44 helicopter which from right to left are Low RPM; Low Fuel; TR Chip; Starter On; Blank (or in R44 Raven II - Carbon Monoxide); MR Chip; Min Temp; Clutch.

As they were returning to the airstrip at the conclusion of the third flight, Mr Wiklund recalled seeing the fuel gauge of the helicopter "*read slightly more than half full"* a couple of minutes before landing.

Mr Wiklund says, before the other members of the survey team arrived back at Gunpowder, he observed Ms Stott and Mr Bielenberg refuelling the helicopter. This exhausted the fuel in the first drum and they needed to take some from the second one. Mr Smit, on the other hand, believes the refuelling was done after lunch when he and the other members of the ground crew were driving away. He agrees this refuelling necessitated use of the fuel in the second drum.

After the third sortie, the survey team members ate lunch at the airfield and discussed the program for the afternoon. It was decided that Messrs Lancaster, Powell and Bielenberg would continue with the aerial survey and the other members of the group would continue with ground survey work. The two groups would rendezvous at Mount Kelly between 3.00 and 3.30 pm. This would allow time for those on the ground to drive to Mt Kelly. Mr Ellis and Mr Drysdale would then take the place of Messrs Powell and Lancaster in the helicopter for the last sortie of the day.

At about 1.10 pm Messrs Ellis and Drysdale left the airfield in their vehicle and at about 1.30 pm Messrs Smit and Wiklund followed in their vehicle to also travel by road to Mt Kelly. Before leaving, Mr Wiklund observed Mr Lancaster in the front left hand seat of the helicopter beside Ms Stott with Mr Powell in the rear left seat and Mr Bielenberg in his "usual" position in the back right seat. The rotors of the aircraft were turning but Mr Wiklund did not see the helicopter take-off. This was the last time that he saw the occupants of the aircraft. Neither he nor Mr Smit saw or heard the helicopter in flight again.

At about 3.30 pm the ground crews met up at the Mount Kelly site and went to a large cleared area at the intersection of two tracks which they considered to be a suitable site for the helicopter to land.

The helicopter is overdue

By 4.00 pm the helicopter had not arrived and Messrs Wiklund and Smit left Messrs Ellis and Drysdale to continue to wait for it while they continued with the exploration.

Messrs Ellis and Drysdale say they thought they heard the sound of a helicopter in the distance on two occasions between about 4.15 and 5.15 pm. However, they did not see any helicopter and when VH-HBS did not arrive at the nominated rendezvous site they continued with their tasks and at about 6.30 - 6.45 pm the ground survey crew all met at the Lady Annie Camp, north of Mt Kelly without any contact having been made with the helicopter.

At about 6.45 pm, Mr Ellis contacted Mr Julian Graham a co director of Mr Bielenberg's company and told him of the situation. Mr Graham went to the NAH office at Mt Isa Airport, and took up with Mr Logan who advised he had

heard nothing from Ms Stott since their short phone call before lunch. At about 7.30 pm Mr Logan advised AusSAR of the missing aircraft and shortly after 8.00 pm he also contacted Mt Isa police to report the helicopter crew missing.

Messrs Ellis and Drysdale drove back to the Mount Kelly rendezvous point at about 10.00 pm to see if the helicopter had landed there. On finding no sign of it they returned to the Lady Annie camp for the night.

The search

AusSAR commenced a night time search using a fixed wing aircraft from Darwin equipped with forward-looking infrared imaging equipment. However, no reports of any distress calls from VH-HBS were received and there were no reports of anyone being alerted by the deployment of the crash-activated EPIRB carried in VH-HBS.

The search continued the next day at first light after a rescue helicopter arrived from Townsville. At about 11.15 am the burnt wreckage of the helicopter was located at about 10 km west of the Mt Gordon mine on an isolated hill in rough and steep terrain. The first police team rescuers were lowered from a helicopter onto a hilltop to the west of the crash site and confirmed that all on board the aircraft had perished.

Investigation findings

Identity, cause of death, pilot health

DNA tests and dental records were used to confirm the identity of the bodies found in the wreckage of the helicopter. Autopsies were conducted on those bodies on 27 February. In each case, incineration, likely to have been a result of the crash igniting fuel spilling from ruptured fuel tanks, made it difficult to determine the precise cause of death.

However, there was no evidence that any pre-existing condition compromised the pilot's ability to handle the aircraft. Nor did the investigation disclose any evidence of any illness or physical condition that may have contributed to the crash. On the contrary, the evidence indicates Ms Stott rarely consumed alcohol, and she was healthy and very fit. There is no evidence she was unduly stressed or anxious on the day in question and her colleagues indicate she was a confident, composed and well prepared aviatrix.

Fuel and mechanical issues

The police and the ATSB investigators found evidence of the helicopter striking a low tree and then impacting the ground in a nose down attitude with the skids approximately level. It was apparent the aircraft had impacted the ground with significant downward force. One main rotor blade had contacted the ground but the main rotor blades had not come in contact with the tail boom or the cabin area.

The ATSB's technical analysis of the pre-crash airworthiness of the helicopter was hampered by the extent of destruction of the aircraft both through impact

damage and the fuel fed fire followed the crash. However, on disassembling the engine its engineers found no mechanical defects or abnormalities. That said, the examination of the ignition system was inconclusive. For example, heat damage to the magnetos prevented a determination of their condition at the time of the accident.

The ATSB reported *"the main rotor blades displayed evidence of low rotational energy at the point of impact."* Some of the linkages between the controls and the rotors seem to have been dislodged by the impact but there was no evidence that they had become separated in flight.

While there is a basis to be concerned about whether the fuel drums from which the aircraft was refuelled at Gunpowder were properly secured, I am nevertheless satisfied that fuel from the same batch was tested. Those tests indicated one sample had excessive gum content and another had particulate matter but both were within specifications for AVGAS 100. Further, numerous other aircraft had used fuel from the same batch without reporting any problems and the aircraft had undertaken three flights using fuel from the same drums before the incident flight without apparently suffering any fuel related mal function. I therefore conclude fuel quality did not contribute to the crash.

The maintenance records inspected by the ATSB showed that at the time of the accident all applicable maintenance requirements had been met.

The ATSB concluded that VH-HBS may have suffered a partial engine power loss or encountered turbulence which caused the pilot to apply an *"inappropriate amount of collective, which developed into overpitching and finally main rotor stall".* I shall deal with overpitching in detail below. There is no evidence on which I could find an engine mal-function contributed to the crash.

Environmental factors

The capability of helicopters to operate and hover diminishes as the operating altitude and/or the temperature increases. This effect is referred to as density altitude. At higher altitudes, thin air reduces engine performance as well as the ability of the rotor blades to grab air and fly or hover. As the temperature of the air increases its density deceases.

It is therefore significant that the altitude of Mt Gordon is 312 metres or 1025 feet.

The Bureau of Meteorology information indicated the weather conditions in the vicinity of the accident site in the afternoon of 21 February 2006 were fine with light easterly winds and with turbulence from thermal activity forecast to be "*moderate"* below 8000 ft. The estimated ambient air temperature at the time of the crash was estimated by the ATSB to be 38 deg C. This was significantly hotter than the temperature in the morning when the survey flights commenced.

Flight operations issues

The GPS data recovered and analysed by the ATSB identify the airborne movements of the aircraft on 21 February 2006. In respect of the movements of the aircraft on the morning survey flights the ATSB's analysis is broadly consistent with the evidence of Mr Wiklund and Mr Smit. Notwithstanding some discrepancies or differences in the details recalled by the survey team members who gave evidence at the inquest, there is sufficient corroboration of the calculations undertaken by the ATSB based on the recovered data to accept that the helicopter conducted the survey flights as identified on p3 of the ATSB's report.

The last time recorded in the recovered GPS data was 1405:07, which matched the time indicated on a watch recovered by the police from the wreckage.

The ATSB concluded the aerial survey was conducted at heights ranging from 500 to 1000 feet above ground level but gives no basis for this. Presumably it is what the other members of the survey team told them, although when giving evidence at the inquest those witnesses seemed to think the aircraft was often operating at a lower altitude.

The last recorded GPS data analysed by the ATSB showed that, on its last run, the helicopter was tracking in a south-westerly direction at derived groundspeeds of between 26 and 37 knots. However, in the last 21 seconds before the loss of recorded GPS readings, the track changed to a westerly and then a northerly direction with the derived groundspeed showing a decrease to an average of 7 knots until the aircraft re-established on a south-westerly track increasing speed to an average of 20 knots. The ATSB states that in the absence of additional data and evidence or witnesses, its investigators were unable to determine the possible reasons for the changes in direction of the aircraft.

Overpitching

The ATSB report provides a concise description of the operational characteristics of the R44 helicopter and the relevant aerodynamic forces. The phenomenon of "*overpitching*" is described. In essence, if a pilot adjusts the collective so that the main rotor blades are set to a high angle of attack, but the power required to drive the blades in that formation is greater than the power available in the prevailing conditions, the main rotor RPM will decrease. The rotor is then overpitched.

As the ATSB investigators explained, overpitching is a phenomenon that more frequently happens when the ambient temperature and the elevation are higher and the aircraft is heavy. Overpitching is more likely to occur at low airspeed in transition to or from a hover, especially when manoeuvring.

Recovery from overpitching requires the simultaneous application of more throttles and the lowering of collective pitch to reduce drag. The ATSB report notes: "*This may be counter instinctive to the pilot of a descending helicopter at low altitude".* If the helicopter is flying at low speed and the pilot raises the

collective in an endeavour to compensate for the decrease in rotor thrust, the rotor will slow even more; increasing the descent rate. The helicopter may then enter a condition known as vortex ring state. The response required is to lower the nose and increase speed to fly forward to gain effective translational lift and, if altitude permits, lower the collective. Obviously, these complications are more likely to arise if the pilot attempts to hover when, because of weight, height above ground and the density altitude, the aircraft does not have out of ground effect hover performance.

I can confidently conclude the helicopter would have been operating out of ground effect. It is also not disputed that the already high temperature increased throughout the day and the altitude of the locale would have produced density altitude issues impacting the engine and rotor performance.[5]

Was the aircraft overloaded?

The weight of the aircraft at the time of the crash is more difficult to determine. Relying on fuel consumption data provided by the helicopter manufacturers, what it believed to be the fuel remaining in the drums, the flight times taken from the GPS data and the reports of the surviving survey team, the ATSB initially concluded it was probable the pilot had refuelled the aircraft to near full tanks (180 litres) on each of the three occasions that the aircraft refuelled at Gunpowder airfield. On that basis the fuel on board the helicopter at the time of the accident was estimated to be about 160 litres.

From these calculations, the ATSB determined the aircraft was slightly above its maximum certificated operating weight of 1089kgs when it commenced the final flight. If this is correct, it is of concern because to achieve out-of-ground-effect (OGE) hover performance in the conditions prevailing on the survey flights, the weight of the aircraft should have been 64kg less than the maximum allowable weight, i.e. 1025 kg. Exceeding that limit had the potential to create serious flight operations issues for the pilot if she was not conscious of it. In calculating the hover weight of VH-HBS in the prevailing conditions at the material time, the ATSB calculated the OGE hover performance weight to be 1025 kg; Mr Carter considered that it would be 1032 kg and Mr Matheson calculated that weight to be 1027 kg.

However, during the course of the inquest evidence came to light which may cast doubt on the bases of the ATSB's initial weight calculations. Indeed a number of witnesses changed their views.

Evidence relevant to this issue was given by an experienced helicopter pilot and flying instructor, Mr Hector Matheson, an ATSB Senior Transport Safety Investigator, Mr Stewart Macleod, Mr Logan, and CASA's Flying Operations Inspector, Mr Harold Carter.

[5] The capability of helicopters to operate and hover diminishes as the operating altitude increases. This thinning of the air is known as density altitude. At higher altitudes, thin air reduces engine performance as well as the ability of the rotor blades to grab air and fly or hover

In making his initial load calculations, Mr Matheson assumed that:

- approximately 160 litres of unused fuel remained in the drums from which the aircraft had been refuelled during the day at Gunpowder;
- in the accumulated flying time of 5.6 hrs, the helicopter would have burnt 58 litres per hour (with additional consumption of 15 litres of fuel burnt while on the ground);
- the zero fuel weight of the aircraft was 969 kg;
- the maximum certificated (or permissible) all up take-off weight of the aircraft was 1089 kilos; and
- 1 litre of fuel weighed 0.72 kgs.

However, he changed his position during the inquest and said he agreed with Mr Logan's calculation that there was only about 85-90 litres on board the helicopter at the time of the accident. Mr Matheson sought to qualify the calculations that he had earlier included in his written statement. He accepted that the zero fuel weight of the aircraft should be 973 kg. With the further fuel burn for the last 23 minutes of flight the aircraft would, according to Mr Matheson, have burnt another 23 litres of fuel which, taking into account fuel burnt on the ground at Gunpowder, resulted in there being only some 57 litres of fuel on board the aircraft at the time of the accident. The weight of that fuel would have been 41 kg. Thus, when he gave evidence, Mr Matheson was of the view the weight of the aircraft at the time of the accident would have been 1014 kg.

The revised ATSB calculations are based on some different assumptions from the ones used by Mr Matheson. In particular:-

- the zero fuel weight of the aircraft was 974 kg;
- the accumulated flying time as at the time of the accident comprised 5 hours and 14 minutes with a fuel usage rate of 58 litres/hr; and
- an estimated ground running time of about 42 mins with a fuel usage rate of 30 litres/hr.

On the basis of its revised calculations, the ATSB determined that approximately 141 litres of fuel were on board VH-HBS at the time of its departure on the final flight. Accordingly, there would have been approximately 124 litres of fuel – weighing 89kg – on board the aircraft at the time of the accident. The aircraft's weight would have been approximately 1063 kg. While this is below the maximum certificated weight of 1089 kg it is between 31 and 38 kgs in excess of the OGE hover weight as calculated by the expert witnesses.

The ATSB's revised calculations are consistent with the evidence of Mr Wiklund that he observed that the fuel gauge of the helicopter "read slightly more than half full" a couple of minutes before landing after completion of the third survey flight and that he observed Ms Stott and Mr Bielenberg refuelling the helicopter from the second drum of fuel shortly before 1.00 pm. If the aircraft had about 90-95 litres of fuel remaining after the third survey flight, on either of the scenarios painted by Mr Logan or Mr Matheson, no fuel would

need to have been accessed from the second drum of fuel at Gunpowder airfield. The addition of (at least) some 50 litres of fuel from the first (and only) use of the second drum at Gunpowder airfield would be consistent with the aircraft having approximately 140-145 litres of fuel on board at time of departure on the final flight. Moreover, this would also be consistent with the observations of Mr Wiklund that he and the pilot had filled both tanks to capacity before the morning flight that had commenced at 1105 hrs for a survey flight of just over 1 ½ hrs.

Mr Wiklund recalled hearing Ms Stott comment that the helicopter's fuel consumption had been less than she had planned due to the slower speeds that they had been flying. NAH's submissions correctly point out that it is hard to give this much weight when it is not known what Ms Stott initially expected the fuel burn rate to be. However, if the aircraft had flown more economically than the postulated 58 litres/hr, this would be consistent with more than 145 litres being on board at the time of the final departure from Gunpowder.

Moreover, even Mr Matheson agreed that if the pilot was planning for a possible 2 or 2 ½ hr aerial work sortie with a landing at Mt Kelly before returning to Gunpowder, it is highly likely that she would have ensured that at least some 150 litres of usable fuel was on board the aircraft when she took off.

Much of the revised calculations undertaken by the ATSB and Messrs Logan and Matheson sought to accommodate the ATSB's assertion that the second drum of fuel used in the refuelling of VH-HBS and returned from Gunpowder airfield to NAH's facility at Mt Isa was ¾ full (150 litres). This was based on the claim by the ATSB that they had secured the drums in question and measured the remaining contents. It is now accepted by all parties that the rigor of exhibit control one would expect of the Bureau in such matters was absent in this case.

The initial evidence of the ATSB's investigator, Mr Kevin Chapman, was that two refuelling drums were located at Gunpowder airstrip and identified by Mr Logan as the drums used for the survey flights. According to Mr Chapman, on Friday 24 February 2006, both drums were *"road transported back to Mt Isa by the operator in company with one of the ATSB investigators, Mr Simon Grummett".* When the drums were inspected on Saturday, one was said to be "*nearly empty*" and the other drum to be "*¾ full - 150 litres remaining*".

When giving evidence about the return of the fuel drums from Gunpowder, Mr Logan said initially that he had "*helped the ATSB load those drums onto the trailer and we brought them back in".* He recalled doing this on the Thursday or Friday.

However, Mr Ellis gave evidence that he attended NAH's facility on Thursday morning before returning to Brisbane and was shown the two drums said to have been used for the refuelling of VH-HBS by Mr or Mrs Logan. When asked to comment on that evidence, Mr Logan was less sure of when the drums were returned to his facility and by whom.

Mr Julian Graham said the vehicle used by the survey team to take the drums of fuel to Gunpowder airfield on the Monday before the aerial survey commenced was a Lodewyk vehicle and that he together with other Lodewyk employees retrieved the vehicle, the fuel drums and the fuel pump used in the refuelling of VH-HBS on the Wednesday after the wreck of VH-HBS had been found.

Mr Graham said he returned the drums and fuel pump together with four other drums used for refuelling search aircraft at Gunpowder airfield on the Wednesday morning to NAH's hangar on Wednesday afternoon. Another vehicle collected other drums of fuel and Mr Graham did not see any fuel drums left at the airfield before returning to Mt Isa that day. Mr Graham escorted Mr Ellis to NAH's premises on the Thursday morning before Mr Ellis departed Mt Isa for Brisbane.

In a subsequent submission the ATSB's lawyers acknowledged that in the absence of a contemporaneous record, Mr Chapman is uncertain whether the drums in question were returned to NAH's facility on 24 February 2006. However, they confirmed that the two drums from which fuel samples were taken and the contents measured on Saturday 25 February 2006 were "*drums identified by the operator NAH at Mt Isa as the drums of fuel used for VH-HBS".*

Mr Logan now accepts the drums used to fuel the incident flight were returned from Gunpowder by Mr Graham on the Wednesday afternoon. He also accepts that there was some "*confusion*" as to the batch numbers of the returned fuel drums and although it is asserted on his behalf that "*when the drums were returned to the hangar by Graham they were put to one side"* and the "*drums were not able to be confused with other fuel drums*", it is apparent from the evidence of both Mr Graham and Mr Ellis that six drums of fuel were returned from Gunpowder airfield and placed together in NAH's hangar.

From the evidence of both Mr Logan and Mr Chapman it appears that no steps were taken on the Thursday 21 Feb 2006 to quarantine the fuel drums in question – on Mr Logan's account of events he had no appreciation that the fuel drums had already been returned to NAH's hangar.

The uncertainties as to the process adopted for measuring the fuel remaining in the recovered drums suggest that any calculations as to the likely operating weight of VH-HBS at the time of its loss of control should not be based on assumptions derived from the amount of fuel reported by the ATSB as being in the drums.

I also accept NAH's submission that possible variations in the fuel consumption rates and uncertainties about how long the aircraft was operating on the ground and how much climbing or hovering it did during the four flights makes accurate calculations of the total fuel used on the day impossible.

In contrast, the ATSB's initial calculation that VH-HBS had approximately 160 litres on board when it crashed is supported by a number of other factors: in

particular, the observations of Mr Wiklund as to the refuelling of both tanks to full capacity on an earlier flight and his observation of the pilot and passengers pumping fuel from the second drum before the final flight. However the most compelling factors is the pilot's knowledge that she needed enough fuel for an extended sortie of two to two and half hours that would include a landing and take off from a site without access to fuel. The probative force of these factors has not been diminished by variations in the evidence received during the inquest. Nor do I accept the submissions made on behalf of NAH that because the aircraft was able to hover during the morning flights, attempting to do so would not have been problematic on the incident flight, mid afternoon. That submission ignores the effect of the increased air temperature at that time of day. In my view the totality of the evidence supports the conclusion that at the time of the accident the aircraft exceeded its OGE hover weight.

The cause of the crash

Using the charts in the R44 Pilot Operating Handbook the pilot is able to calculate the hover performance of the helicopter in the prevailing conditions. These calculations are, as outlined in the ATSB report, *"predicated on the availability of maximum allowable engine power"*. Although the maximum power available is calculated from outside air temperature and pressure altitude before a flight begins, it may only be discovered to be not actually available when a power check is undertaken in flight. However, according to Mr Logan this check was not part of the standard operating procedures for the pilots of NAH.

The passengers were not weighed nor even asked their weight. The evidence did not disclose any practice among NAH pilots of calculating fuel weight.

This raises the real possibility that Ms Stott only discovered she did not have hover performance during the incident flight when she attempted to manoeuvre the aircraft in that fashion to assist her clients. The evidence establishes that earlier, in the cooler part of the day, with different load, the aircraft did have this capacity. To suddenly discover that it could no longer hover could understandably precipitate an inappropriate response.

I accept NAH's submission that an inability to hover does not necessarily lead to a crash. However, it is entirely feasible that a contributing factor leading to the pilot experiencing a relatively sudden and catastrophic loss of control of the helicopter was the slowing of the aircraft below translation speed at an altitude outside of ground-effect in the course of attempting to hover in circumstances in which, as a result of its gross weight and the ambient air density, the helicopter did not have sufficient hover performance to sustain flight. The very experienced helicopter pilots who gave evidence and contributed to the investigation reports testified to the critical nature of the counter intuitive response to the aircraft losing lift and the small time frame in which a pilot must execute it. The pilot in this case was inexperienced and new to survey work. She was operating at low altitude. When coupled with

human factors such as fatigue and high workload[6] it is foreseeable she may not have responded appropriately. I accept also that a contribution of unexpected turbulence can not be excluded. However, I am not required to exclude every possibility, but rather to establish, if possible, what is more likely to have occurred.[7]

Findings required by s45

I am required to find, as far as is possible, who the deceased were, how they died, when and where they died and what caused the deaths. As a result of considering all of the material contained in the exhibits and the evidence given by the witnesses, the material parts of which I have summarised above, I am able to make the following findings.

Identity of the deceased - The deceased persons were:

Paul Carl BIELENBERG

Thomas William LANCASTER

Derek Victor POWELL

Vita Mara STOTT

How they died - All died when the helicopter Ms Stott was piloting as part of an investigation by a mining survey team crashed. The precise cause of the crash has not been ascertained. There is no evidence of any mechanical failure. Ms Stott's lack of experience in this type of flying and the overloading of the aircraft may have contributed.

Place of death - The crash occurred 10 kilometres west of the Gunpowder Mine. All occupants of the aircraft died at the scene.

Date of death - The deaths occurred on 21 February 2006

Cause of death - All died from incineration.

Section 46 recommendations

Section 46 provides that a coroner may comment on anything connected with a death that relates to public health and safety, the administration of justice or ways to prevent deaths from happening in similar circumstances in the future. That requires the coroner to consider whether the death under investigation

[6] I don't accept NAH's submission that following the waypoints on the GPS in her lap was no more demanding than is usual for pilots checking charts.
[7] Hurley v Clements & Ors [2009] QCA 167

was preventable and/or whether other deaths could be avoided in future if changes are made to relevant policies or procedures.

Two issues warrant consideration from that perspective in this case:-

- The experience and supervision of NAH pilots undertaking aerial survey work; and
- Investigation exhibit control

The operator's procedures

Submissions made on its behalf assert the operator has proactively sought to develop a safety culture among its staff and that its positive attitude to safety has been recognised by CASA as evidenced by the regulator citing the operator as an example for others in its *Flight Safety* magazine. I accept those submissions. That doesn't mean its operations could not be improved.

NAH undertook charter and aerial work pursuant to an Air Operators Certificate issued by CASA. As part of the process of obtaining that AOC the operator had to produce an operations manual that CASA accepted as appropriate for the work the operator was proposing to do. Because of this NAH submits it cannot be criticised for any deficiencies in those procedures. Be that as it may, it does not mean the operations manual should not be improved, something the operator seems to resist, urging that I focus only on industry wide issues, ignoring the fact that the inquest received little evidence about industry wide practices but focused intently on NAH's operations.

I am concerned by the evidence indicating the aircraft took off on the incident flight while above its maximum certificated take off weight. I am concerned by the evidence indicating that when it crashed its weight is likely to have exceeded that at which it could hover out of ground effect. I consider deficiencies in the operator's procedures which did not mandate that the pilot weigh passengers or routinely calculate the fuel weight may have contributed to these undesirable circumstances arising, unbeknown to the relatively inexperienced pilot.

Part D.2 of the company's operations manual deals with aerial surveys. It provides that prior to departure the pilot in command shall be briefed by the chief pilot on the proposed tasks to be undertaken.

Mr Logan says it was his practice to always remind his pilots about the need for caution as weather conditions change throughout the day and he assumed he spoke to Ms Stott about refuelling and loading the aircraft as was his habit but he candidly acknowledged that he could not say exactly what reminders or warnings he gave her on this day. He was keen to confirm that he discussed these issues with pilots regularly but he had no evidence of it or apparently any documented or regimented system for analysing the issues likely to confront a pilot on a given job. Rather, he seemed to believe he could rely on a pilot's training, his observation of them as they went about their work and the twice yearly check flight each pilot was obliged to undergo.

Mr Logan quite reasonably asserts he is entitled to expect pilots will have regard to the performance charts contained in the aircraft's pilot's operating handbook. However those charts for obvious reasons only include hover performance for the aircraft up to its certificated take off weight. As we now know, it is likely the incident aircraft was overweight when it took of on its last flight. Mr Logan could have alerted Ms Stott to this possibility by ensuing that when she, he and Mr Bielenberg met two days before the survey flight to prepare for it she was reminded that the passengers should be weighed when they arrived in Mt Isa. He could have discussed with her the limitations the passengers' weight might have in relation to how much fuel she could carry. There is no evidence this was done.

It also seems to me desirable that the operations manual require pilots to undertake power checks at an appropriate juncture in all flights so that the actual performance of the aircraft, as distinct from the theoretical power which might be calculated from the performance charts, is known to the pilot before he or she is surprised by any shortcoming.

The operator rejects the suggestion that aerial surveys should only be undertaken by pilots with at least 500 hours in command on the basis that an operator should be able to asses the competency of any particular pilot for the job at hand rather than simply relying on a crude measure such as total hours. This objection sits uncomfortably with the exact same limitation on pilots undertaking photo flights that is contained in the operations manual. Presumably the limitation on pilots conducting photos flights contained in the operations manual reflects the safety notice issued by the manufacture which recommends this.

The manufacturer has now amended that safety notice to extend the limitation to survey flights. Its views would not seem to accord with those of the chief pilot of NAH concerning the tasking of new pilots to undertake survey flights.

Its revised safety notice issued in April this year commences:-

> *There is a misconception that aerial survey and photo flights can be flown safely by low time pilots. Not true. There have been numerous fatal accidents during aerial survey and photo flights, including several involving Robinson helicopters.*

It goes on to stipulate aerial survey flights should only be conducted by well trained, experienced pilots who have at least 500 hours in command in helicopters, over 100 hours in the model flown and who have extensive training in both low RPM and settling with power recovery techniques.

Manufacturers' safety notices are not binding on operators. They can be ignored unless they are incorporated into the aircraft's flight manual. In that case regulation 138(1) of the Civil Aviation Regulations is activated - *the pilot in command of the aircraft must comply with a requirement, instruction, procedure or limitation concerning the operation of the aircraft that is set out in the manual.*

In my view safety notices warrant being given more force and any suggestion that the obligation to comply with the flight manual does not include ensuring the aircraft is operating within the parameters of its performance charts should be repudiated.

I have raised a number of concerns based on the evidence received at the inquest. That did not equip me with sufficient information as to how these apparent shortcomings should be remedied. No doubt CASA has access to such information

Recommendation 1 - CASA audit NAH's operations manual

I recommend CASA audit the operations manual of NAH to consider whether the apparent shortcomings identified in this inquest could be remedied by amendments to the manual.

Recommendation 2 – Safety notices and performance charts

I recommend CASA consider whether the current regulatory arrangements give sufficient force to manufacturers' safety notices and the performance charts contained in pilots' operating handbooks. I recommend CASA consider issuing an advisory in its Flight Safety magazine drawing attention to the risk of not observing these limits. Further, if it does not already do so, CASA's acceptance and audit of AOC holders' operations manuals should have regard to how operators purport to operationalise these guidelines.

Exhibit control

The ATSB accepts that its investigative processes failed in that it was not able to be sure the fuel drums used to fuel the incident aircraft were controlled as quickly and as tightly as was desirable. I readily acknowledge the challenges the Bureau faces in scene preservation and exhibit control when aircraft crashes occur in such remote areas. However I am sure the Bureau aims to do better.

Recommendation 3 – The ATSB's exhibit control procedures

I recommend the ATSB review how exhibit control was undertaken in this case with a view to minimising the possibility for errors in future.

Michael Barnes
State Coroner, Queensland
14 September 2009