Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation – AO-2006-002
Final

Collision with terrain - 19 km NE of Collarenebri, NSW
9 December 2006
VH-CJZ
Air Tractor Inc. AT802A

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Federal Aviation Administration report ‘Carbon Monoxide : A Deadly Menace’

Aviation Medicine – John Ernsting and Peter King.

Abstract

On 9 December 2006, the pilot of an Air Tractor Inc. AT802A aircraft, registered VH-CJZ, was conducting night agricultural spraying operations under the night visual flight rules, at a property 19 km NE of Collarenebri, NSW. In conjunction with a pilot in another agricultural spraying aircraft from the same aircraft operator, the Air Tractor pilot was utilising an airstrip located on the property as a base for the spraying operation. At about 2140 Eastern Daylight-saving Time, the aircraft was returning to the airstrip when it impacted the ground 1.4 km WSW of the landing strip. The pilot was fatally injured. The aircraft was destroyed by impact forces and a post-impact fire.

Earlier that evening, the pilot had made a 20-minute positioning flight from the operator's base at Wee Waa, NSW, to the airstrip. The pilot then conducted two 30-minute spraying flights, with a short period on the ground to replenish the load of chemical fertiliser. The aircraft remained running while that replenishment was conducted. The accident occurred when the pilot was returning to the airstrip at the conclusion of the second spraying flight.

Examination of the aircraft wreckage revealed no evidence of an in-flight fire or any mechanical fault with the aircraft, engine, or systems which may have contributed to the occurrence. The intensity of the post-impact fire, deformation to the integral wing fuel tank structure and ground marks, indicated that there was sufficient fuel on board the aircraft for the operation. There was no evidence that the aircraft struck trees or powerlines.

The reason for the aircraft impacting the ground could not be conclusively determined. It was possible that the pilot may have experienced a medical event that was not evident during the post-mortem medical examination. However, based on the evidence available it is probable that the pilot experienced spatial disorientation and a subsequent loss of control of the aircraft resulting in it impacting the ground.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external organisations.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

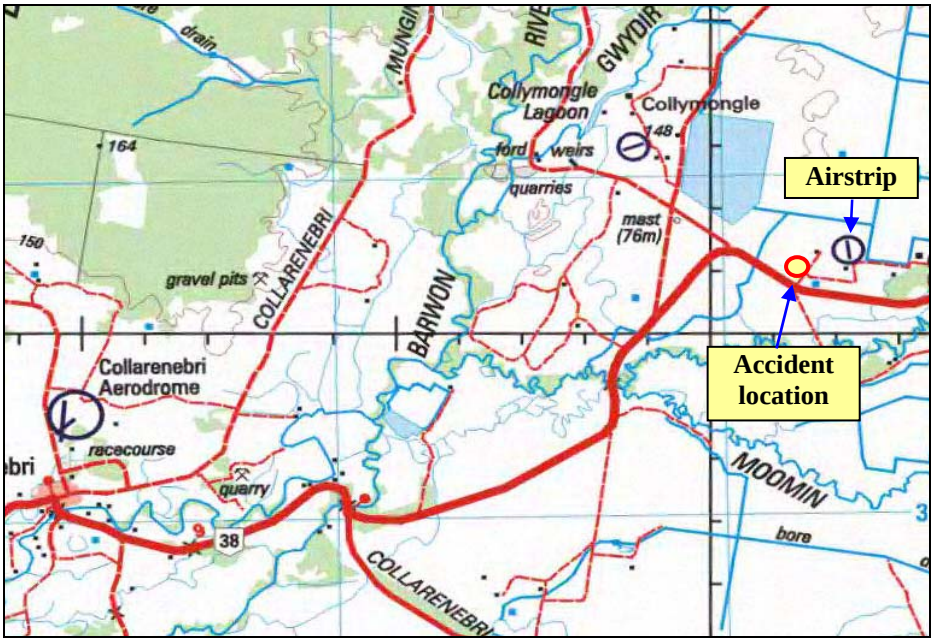
FACTUAL INFORMATION

History of the flight

On 9 December 2006, the pilot of an Air Tractor Inc. AT802A (AT802A) aircraft, registered VH-CJZ, was conducting night agricultural spraying operations under the night visual flight rules (night VFR)[1], at a property located 19 km NE of Collarenebri, NSW (Figure 1). The pilot was utilising an airstrip located on the property as a base for the spraying operation in conjunction with a pilot in another agricultural spraying aircraft from the same operator. At about 2140 Eastern Daylight-saving Time[2], the aircraft was returning to the airstrip when it impacted the ground 1.4 km west-south-west of the landing strip. The pilot, who was the sole occupant, was fatally injured. The aircraft was destroyed by impact forces and post-impact fire.

Earlier that evening, the Air Tractor pilot had flown that aircraft from its home base at Wee Waa, NSW, to the airstrip. The flight duration from Wee Waa to the property was about 20 minutes. Prior to the accident, the pilot had conducted two 30-minute spraying flights, with a short period on the ground between each flight, to replenish the load of chemical fertiliser. The aircraft's engine remained running while that replenishment was conducted. The accident occurred when the pilot was returning to the airstrip at the conclusion of the second spraying flight.

Figure 1: Accident location



1 Night VFR flight may be described as flight at night using external visual references to ground objects, such as the horizon and terrain illuminated solely by lights on the ground or adequate celestial illumination, as a primary source of reference for aircraft orientation.

2 The 24-hour clock is used in this report to describe the local time of day. Eastern Daylight-saving Time is UTC +11 hours.

Pilot information

The pilot had held a commercial pilot (Aeroplane) licence since 1996 and was appropriately endorsed to fly the AT802A type. He held a Night VFR Agricultural Rating and a Grade 1 Agricultural Rating, both issued by the Civil Aviation Safety Authority (CASA) in 2001. He held a valid Class 1 CASA Aviation Medical Certificate, with a restriction to wear distance vision correction. He held a CASA Chief Pilot approval and an instrument of appointment as Chief Pilot for the aircraft operator, issued in 2005.

The pilot's *Flying Log Book* was incomplete, with no entries made after March 2006. Based on an examination of the pilot's *Flying Log Book* and other records provided by the operator, the investigation determined that the pilot had accumulated a total of about 4,110 flying hours, including about 460 hours of night agricultural flying prior to the night of the accident. Records indicated that in the 12 months prior to that night, the pilot had accumulated a total of about 77 hours of night agricultural flying operating the Air Tractor Inc. AT502A[3] and 0.1 hour in the AT802A aircraft. His last recorded night agricultural flying was 0.1 hour in the AT802A aircraft 7 months prior to the accident. During the same period he had flown a total of 217 hours of day agricultural flying operating the Air Tractor Inc. AT502A and 123 hours in the AT802A aircraft.

During the day preceding the accident, the pilot spent his time at leisure with his family and was reported to be well rested and in good spirits. On the day of the accident he had woke at about 0430 'to do a local job' and returned at about 0800. Between 1330 and 1630, the pilot slept in preparation for the night's flying.

On the evening of the accident, the pilot had flown the accident aircraft for about 1 hour 20 minutes.

Medical information

Family, friends and work colleagues of the pilot reported that he was very fit and a non-smoker who maintained his health through regular exercise. After landing at the property following the flight from Wee Waa, the pilot had discussed the intended night operations with the pilot of the second aircraft. That pilot reported that the Air Tractor pilot appeared to be in good spirits and keen to participate in the night's spraying operation.

Post-mortem medical examination found 12 percent saturated carbon monoxide in the pilot's blood sample. Forensic medical advice stated that such a relatively high level of carbon monoxide was consistent with exposure to smoke during the post-impact fire. However, other possibilities may have contributed to that exposure as the level found would not be unusual for a person who had smoked or worked in a smoke-laden environment.

3 The AT502A is a similar design to the AT802A but in comparison is smaller with a less powerful engine and has a reduced payload capability.

Elevated levels of carbon monoxide in the range found can produce insidious marginal impairment of performance that could affect aircrew performance in flight[4].

Although an undetected medical condition could not be ruled out, no evidence of a physiological or other condition could be found that may have been a factor in the accident.

Night VFR agricultural recent experience requirements

At the time of the accident, Night VFR Agricultural recent experience requirements were detailed in CASA Civil Aviation Order (CAO) 40.2.2, Appendix II, section 5, and included:

> 5.1 For the purposes of paragraph 9.2, the holder of a night V.F.R. agricultural rating must not exercise the authority given by the rating unless:
>
> (a) he or she has obtained a minimum of 20 hours flying experience at night in agricultural operations in the 12 months preceding the flight; and
>
> (b) where continuity of night spraying is broken by more than 35 days, he or she has practised the necessary manoeuvres by night in an unladen agricultural aircraft prior to resuming night spraying operations.
>
> 5.2 Where the holder of a night V.F.R. agricultural rating does not meet the recent experience requirements specified in subparagraph 5.1 (a), he or she shall carry out recency flying at night to the extent nominated by CASA. He or she may also be required to demonstrate in flight to CASA, an approved testing officer or an approved pilot his or her continued fitness to hold a night V.F.R. agricultural rating.

The investigation was unable to confirm if the pilot had complied with CAO 40.2.2, Appendix II, paragraph 5.1 (b).

Airstrip information

The airstrip being used for the spraying operation had a gravel surface, was aligned about 160/340 degrees magnetic, was about 1,200 m (3,937 ft) long and was equipped with permanent, white side lighting. Infrastructure at the airstrip included refuelling facilities, aircraft shelters and other buildings.

Witnesses reported that on the night of the accident, both pilots were taking off to the north-west and landing to the south-east. The chemical loading facility was adjacent to the strip.

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4 Lacefield, D.J., Roberts, P.A., and Grape, P.M. (1982). *Carbon Monoxide in-flight incapacitation: An occasional toxic problem in aviation.* Civil Aeromedical Institute. Federal Aviation Administration. Oklahoma City, Oklahoma.

Meteorological and astronomical information

Bureau of Meteorology weather observations for the Collarenebri area recorded weather conditions on 9 December 2006 at 1500 as a light north-easterly wind, temperatures of 32 degrees Celsius, about 7/8 cloud cover and no rainfall.

Witnesses in the vicinity of the airstrip reported that at the time of the accident, wind conditions were calm and the sky was clear.

Sunset was at 1956 and the ending of evening astronomical twilight[5] was at 2132. Moon rise was at 2347.

Artificial ambient illumination

Artificial illumination in the vicinity of the airstrip included the white landing strip side lights, building and infrastructure floodlights, marker lights at the fields being sprayed and vehicle lights from traffic proceeding along a nearby highway. Witnesses reported that, at the time of the accident, the aircraft was flying away from those light sources.

Communications

The pilots of both spraying aircraft were communicating with ground staff, using radios fitted to their aircraft and vehicles. The pilot of the other aircraft and ground staff reported that no radio communications were received from the accident pilot to indicate any problems. During the second flight, the accident pilot discussed by radio, with ground staff, the prevailing weather conditions and noted that the wind speed had reduced to less than the optimal wind speed of 15 kts required for effective spraying. The ground staff reported that the pilot stated he was intending to return to the airstrip after he had depleted his chemicals to assess whether to continue spraying operations.

There was no further radio communication with the pilot.

Aircraft information

The AT802A aircraft was a single-seat agricultural aircraft configured for spraying operations and powered by a Pratt and Whitney Canada PT6A-65AG gas turbine engine. The engine operated a Hartzell Inc, 5-bladed, HC-B5MP-3C propeller that was designed to constant-speed, reverse or feather.

Aircraft maintenance records indicated that the aircraft was maintained in accordance with the approved CASA system of maintenance. At the time of the accident, the aircraft and engine had accumulated about 3,100 hours total time in service. The propeller had operated for about 150 hours since overhaul. The last

5 Evening astronomical twilight is defined as the instant in the evening, when the centre of the sun is at a depression angle of 18 degrees below an ideal horizon. At this time the illumination due to scattered light from the sun is less than that from starlight and other natural light sources in the sky.

scheduled maintenance was performed about 3.0 hours prior to the accident. Prior to the accident, there were no reported aircraft defects.

The aircraft was loaded with chemical fertiliser. The chemical manufacturer's *Material Safety Data Sheet*, did not specify any health hazard associated with the chemical. The pilot had been trained in the handling of hazardous chemicals associated with agricultural operations.

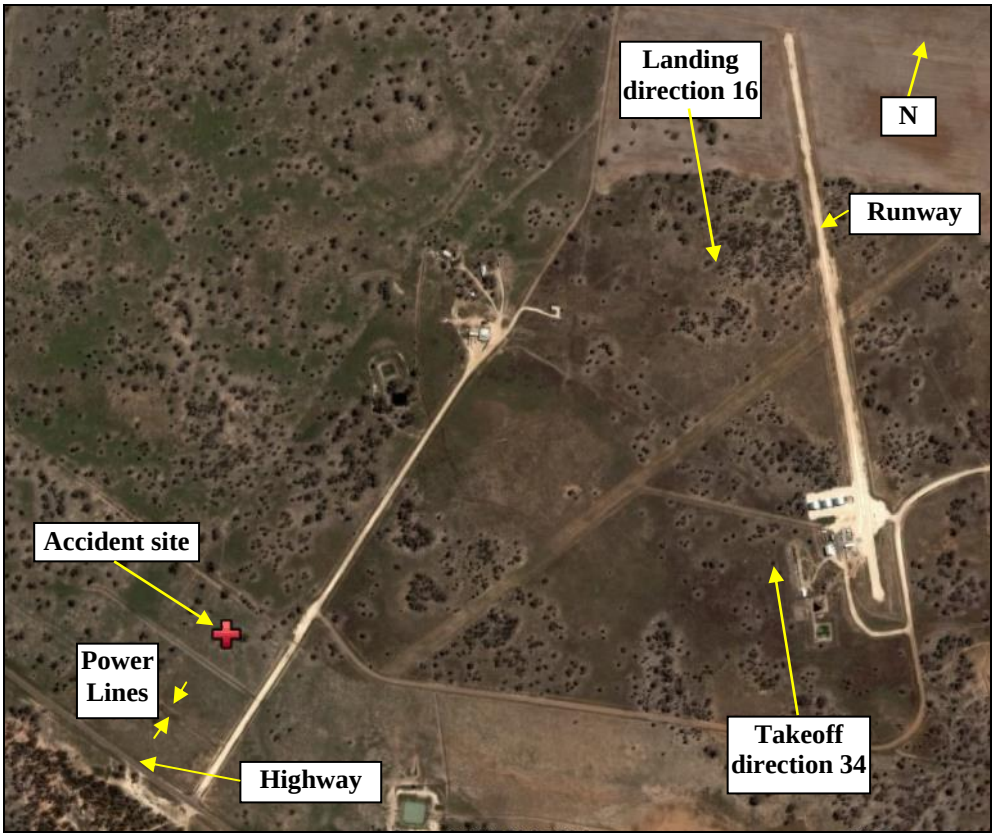
Fuel

The investigation could not establish the quantity or quality of fuel on board the aircraft at the time of the accident.

Wreckage information

The aircraft impacted the ground in flat, open terrain that was sparsely covered with trees of about 15 to 20 m in height (Figure 2). A powerline ran parallel to the nearby highway, about 100 m from the initial point of impact. There was no evidence that the aircraft had contacted either the trees or the powerline.

Figure 2: Airstrip and accident location



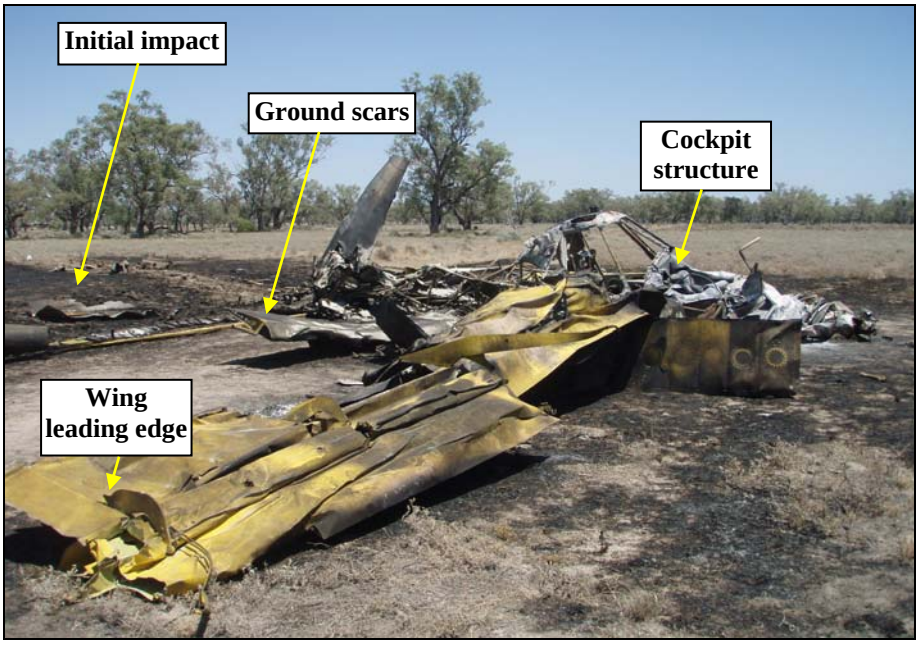
The wreckage trail was about 45 m in length. Wreckage examination and on-site evidence indicated a probable impact angle of between 7 and 27 degrees, which was steeper than a normal landing approach (normally 3 to 5 degrees).

The cockpit, fuselage, wings and engine suffered serious damage[6] from impact forces and an intense post-impact fire (Figures 3 and 4). Vegetation in the vicinity of the initial impact point to the most forward portion of the wreckage was burnt.

Both wings were ruptured and deformed from fluid pressure and impact damage adjacent to the wing integral fuel tank. This was consistent with fuel moving foreword with inertia in a confined space.

The aircraft's wing flaps were estimated to be at an angle of about 10 degrees, which was consistent with the landing approach configuration.

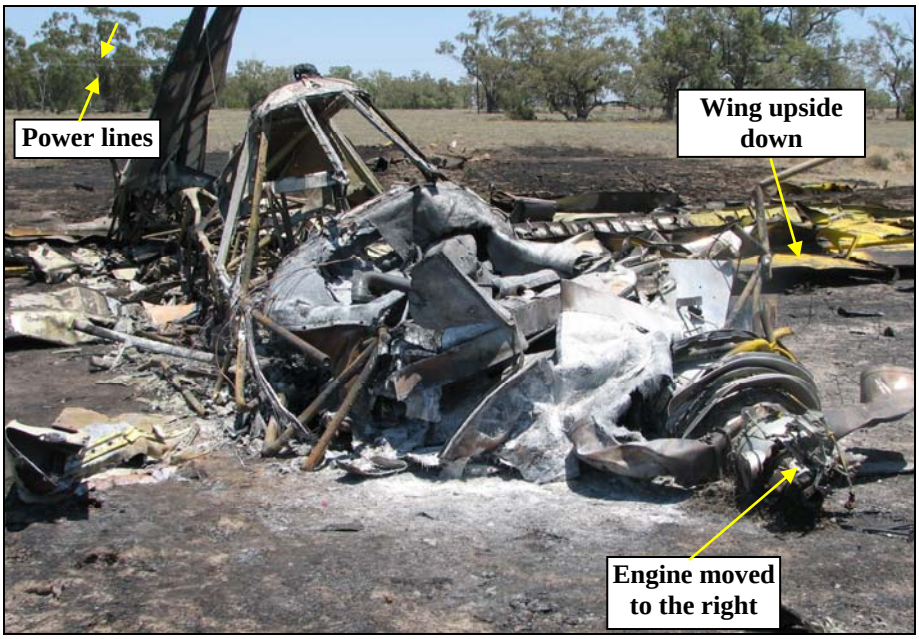
Figure 3: Aircraft wreckage and wreckage trail



Examination of the aircraft wreckage at the accident site did not reveal any evidence of an in-flight fire or any mechanical fault with the aircraft, engine or systems, which may have been a factor in the accident. The propeller displayed evidence of rotation at impact via scrape marks across the face of several blades and torque via longitudinal twisting of several blades.

6 The Transport Safety Investigation Regulation 2003 defines 'serious damage' and includes damage which results in the 'destruction of the transport vehicle'.

Figure 4: Aircraft wreckage with trees and power poles/lines.



The engine and propeller was retained by the ATSB for further examination

The propeller was subsequently transported to a CASA approved propeller maintenance organisation for disassembly and examination under the supervision of the Australian Transport Safety Bureau (ATSB). Information from the propeller maintenance organisation indicated that:

- the propeller blades were in the fine pitch range at ground impact
- the propeller was being driven by the engine at the time of impact with the ground
- the number 4 and 5 blades were torn from the hub due to ground impact forces
- numbers 4 and 5 blade pilot tubes may have been partially failed prior to contact with the ground.
- number-1 blade failed due to impact forces.
- number-2 blade pilot tube had failed at some indefinite time during operation prior to ground impact.

The propeller blades and hub were shipped to the ATSB's Canberra office for more detailed metallurgical examination. The Bureau's examination found no indication of pre-existing fractures or cracking of the pilot tubes or of the movement of a blade within its clamping assembly.

The investigation sought advice from the propeller manufacturer in the United States. The manufacturer considered that the propeller damage was consistent with impact overload forces.

The engine was later released to the operator as no further examination was necessary.

Survivability information

The pilot's seat pan was deformed in a downward direction, at an angle of approximately 20 to 22 degrees, indicating a significant vertical 'g' load at impact. The locking mechanism of the seat belt was found in the closed position.

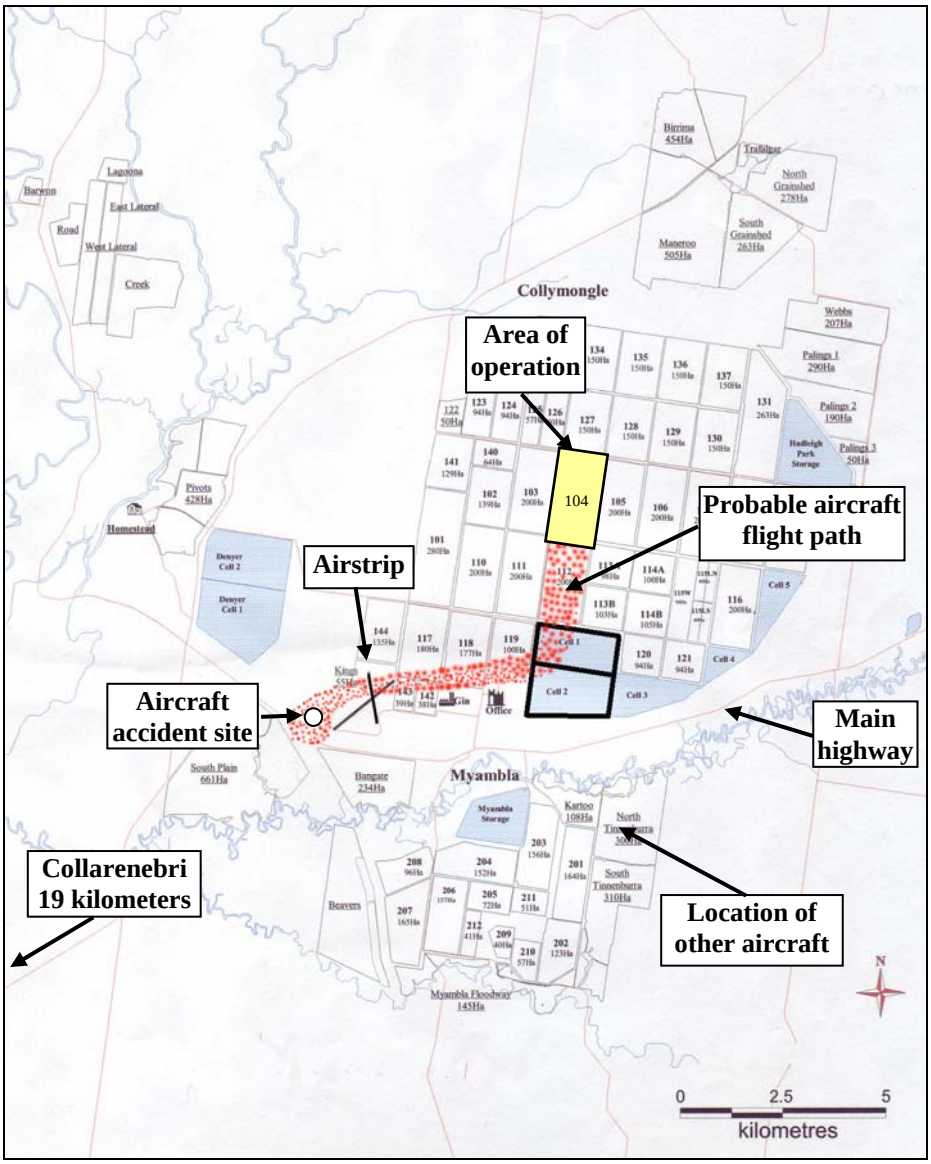
The post-mortem report stated that '…the principle [sic] cause of death was multiple injuries in combination with smoke inhalation and incineration as these pathological processes were all acting in conjunction at or around the time of death'.

Witness information

Witnesses on the ground reported seeing the Air Tractor fly from the vicinity of field 104 (Figure 5) in a southerly direction, over cells 1 and 2, then overfly the airstrip in a south-westerly direction. A witness near the airstrip, who was over-flown by the accident aircraft, reported that '…the aircraft descended with a high rate of descent in a flattish attitude…', and that the aircraft's landing light was illuminated. In addition, that witness reported that a truck was travelling along the highway in a westerly direction, in the vicinity of the aircraft flight path, with a '…lot of lights on…'. That report was subsequently clarified as truck side-running lights, and not headlights or driving lights. The witnesses reported that the aircraft appeared to be operating normally, with no unusual flight characteristics or sounds.

A witness travelling west along the highway, reported seeing a '…bright light…' about 1 km ahead of his vehicle, descending to the ground at a high angle and high speed, until impacting the ground and igniting. The witness stated that he later realised that what he saw was an aircraft impacting the ground.

Figure 5: Site location



Spatial disorientation

Spatial disorientation can be defined as the inability of a pilot to correctly interpret aircraft attitude, altitude or airspeed in relation to the earth or other points of reference. More simply, it is the inability to tell which way is up.

Spatial disorientation occurs when the brain receives conflicting or ambiguous information from the visual (eyes), vestibular (inner ear) and proprioceptive (skin, muscles, joints, tendons) sensory systems. There is a high risk of this occurring when a VFR pilot encounters cloud or an area of reduced visibility and no visible horizon. The resulting state of confusion is dangerous for the pilot, as it can lead to incorrect control inputs and the resultant loss of aircraft control.

More information about spatial disorientation can be found in the ATSB aviation research and analysis report B2007/0063 *An overview of spatial disorientation as a factor in aviation accidents and incidents.*

Previous occurrences of Night VFR accidents

The ATSB has investigated a number of previous accidents involving the conduct of flight operations under the night VFR, including[7]:

- 200403006, involving a Mooney Aircraft Corporation M20K, registered VH-DXZ, near Bokarina, QLD, on 15 August 2004.
- 200304282, involving a Bell 407 helicopter, registered VH-HTD, at Cape Hillsborough, QLD, on 17 October 2003.
- 200500004, involving an Air Tractor AT-802A aircraft at Wynella Station, Qld on the 6 January 2005.

7 Available at www.atsb.gov.au.

ANALYSIS

Examination of the aircraft wreckage revealed no evidence of an in-flight fire or any mechanical fault with the aircraft, engine or systems, which may have contributed to the occurrence.

There were no records or reports of any problems with the propeller prior to the accident. The Australian Transport Safety Bureau's examination of the propeller found no evidence to support a finding that the propeller was in an unserviceable condition or was operating abnormally at or prior to the time of the accident.

The intensity of the post-impact fire, fluid pressure damage to the integral wing fuel tank, ground marks, evidence of propeller rotation and engine operation (propeller torque) indicated that there was sufficient fuel on board the aircraft for continued operation. There was no evidence that the aircraft struck trees or powerlines.

The pilot's *Flying Log Book* and records provided by the operator indicated that the pilot had accumulated a total of about 77 hours of night agricultural flying in the preceding 12 months. However, the last recorded night agriculture flying was 0.1 flight hours, which was in the 802A aircraft, 7 months prior to the accident. Notwithstanding, the pilot had successfully flown the un-laden aircraft for about 20 minutes during transit from Wee Waa to the property, and had then flown the laden aircraft for two 30-minute periods while conducting spraying activities, including two landings by night at the airstrip, without any apparent difficulties. It could not be determined if the pilot had met the 'recent' requirements for visual flight rules (VFR) agricultural operations at night as per the CAO 40.2 requirements prior to commencing night agricultural operations. However, at the time of the accident, the pilot had probably met the intent of CAO 40.2.

Post-mortem medical examination did not reveal any abnormalities that might have contributed to the accident. However, although the pilot was fit with a current medical certificate, it was not possible to rule out the possibility that the pilot may have suffered a medical event that was not evident during the post-mortem medical examination. The apparent 12 percent saturated carbon monoxide blood level identified during post-mortem and toxicological examination can affect a person's night vision. The level found would not be unusual for a person that had smoked or worked in a smoke-laden environment. However, the pilot was reported to be a non-smoker and it would be unlikely for a gas turbine-powered aircraft, using aviation kerosene fuel, to produce the necessary elevated levels of carbon monoxide in the cockpit. It is therefore more likely that the elevated carbon monoxide levels were as a result of exposure to the post-impact fire.

The pilot over-flew a well lit landing strip and gave no indication of any problems, despite recent radio communication with ground staff. Had he detected any problems with the aircraft or had he been experiencing any physiological problems, it is likely he would have alerted either the other company pilot or ground staff by radio.

Wind conditions in the area were calm and the night sky was reportedly clear of cloud, with no moon or other celestial illumination. Ground lighting was confined to the immediate airstrip environs and once the pilot had over-flown the illuminated airstrip, no further ground illumination was available to provide him with visual cues. The aircraft's flap position and illuminated landing light was consistent with

an intention to land the aircraft. However, the estimated impact angle of about 7 to 27 degrees nose-down attitude is inconsistent with a normal landing approach.

The reason for the aircraft impacting the ground could not be conclusively determined. However, given the following risk factors:

- the environmental conditions noted above
- the pilot's limited recent night flying experience

and given that:

- the aircraft maintenance records and wreckage inspection did not reveal any abnormalities
- there was no other evidence found that may have contributed to the accident

it is reasonable to conclude that the pilot probably experienced spatial disorientation, which led to either controlled flight into terrain or loss of control of the aircraft resulting in it impacting the ground.

FINDINGS

From the evidence available, the following findings are made with respect to the collision with terrain involving Air Tractor Inc. AT802A, registered VH-CJZ while returning to the airstrip after completing a night agricultural operation, and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- There was minimal ground and celestial lighting available to assist the pilot in maintaining external visual reference when turning towards the landing strip.
- The pilot probably experienced spatial disorientation, which led to either controlled flight into terrain or loss of control of the aircraft resulting in it impacting the ground.

Other safety factors

- The pilot had limited recent night flying experience.