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ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Aviation Occurrence Report – 200500004
Final

Collision with terrain
Wynella Station, Qld
6 January 2005
VH-BQN
Air Tractor AT-802A

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Abstract

On 6 January 2005, the pilot of an Air Tractor AT-802A aircraft, registered VH-BQN, was spraying insecticide on a cotton crop on Wynella Station, 41 km south of Dirranbandi, Qld. The aircraft departed the station airstrip at about 2005 Eastern Standard Time to commence spraying operations and impacted the ground at 2035. The pilot was fatally injured, and the aircraft was destroyed by fire.

There was no evidence that the aircraft was not capable of normal operation at the time of the accident. The pilot had substantial agricultural and general flying experience, but had only recently completed night agricultural flight training. The accident occurred after the end of nautical twilight, there was no moon, and there was a band of cloud over Wynella station. There was virtually no ground lighting in the area. Post-mortem examination identified severe atherosclerotic narrowing of all three coronary arteries.

The lack of recorded and witness information, and the destruction of the cockpit by fire, prevented the investigation from conclusively identifying the factors that contributed to the development of the accident. However, the combination of pilot inexperience in night agricultural operations and the dark night conditions increased the risk of an accident.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

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

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. Accordingly, the ATSB also conducts investigations and studies of the transport system to identify underlying factors and trends that have the potential to adversely affect safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and, where applicable, relevant international agreements. The object of a safety investigation is to determine the circumstances in order to prevent other similar events. The results of these determinations form the basis for safety action, including recommendations where necessary. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations.

It is not the object of an investigation to determine blame or liability. However, it should be recognised that an investigation report must include factual material of sufficient weight to support the analysis and findings. That material will at times contain information reflecting on the performance of individuals and organisations, and how their actions may have contributed to the outcomes of the matter under investigation. 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.

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. While the Bureau issues recommendations to regulatory authorities, industry, or other agencies in order to address safety issues, its preference is for organisations to make safety enhancements during the course of an investigation. The Bureau prefers to report positive safety action in its final reports rather than making formal recommendations. Recommendations may be issued in conjunction with ATSB reports or independently. A safety issue may lead to a number of similar recommendations, each issued to a different agency.

The ATSB does not have the resources to carry out a full cost-benefit analysis of each safety recommendation. The cost of a recommendation must be balanced against its benefits to safety, and transport safety involves the whole community. Such analysis is a matter for the body to which the recommendation is addressed (for example, the relevant regulatory authority in aviation, marine or rail in consultation with the industry).

FACTUAL INFORMATION

History of the flight

On 6 January 2005, the pilot of an Air Tractor AT-802A aircraft, registered VH-BQN, was spraying insecticide on a cotton crop on Wynella Station, 41 km south of Dirranbandi, Qld. The aircraft departed the station airstrip at about 2005 Eastern Standard Time[1] to commence spraying operations and impacted the ground at 2035. The pilot was fatally injured, and the aircraft was destroyed by fire.

This was the first occasion that the pilot had conducted agricultural operations at Wynella. He was being assisted by two support personnel, a mixer[2] and a marker. During the late afternoon and early evening, while it was still light, the pilot completed five flights from the Wynella airstrip. At dusk, as the pilot was preparing to take off, after the aircraft had been refuelled and the hopper reloaded, he found that he was unable to turn on the radio-activated runway and paddock marker lights with the aircraft radio. To activate the lights, the marker drove a vehicle near each of the lights and activated them using the radio in the vehicle. This took some time and, while discussing the night spraying operation with the mixer, the pilot expressed both frustration at not being able to transition gradually to night flight by flying through the dusk period, and anxiety about the lack of a horizon due to the dark night conditions. He also said that he intended to stop spraying in about an hour and a half and finish the job the following morning.

The complex of paddocks being sprayed was marked by radio-activated lights at each corner and the pilot was using a Global Positioning System (GPS) system for directional guidance. The marker was assisting the pilot by positioning the vehicle in line with each spray run. He was able to communicate with the pilot by using the radio in the vehicle. The pilot was conducting spray runs in east-to-west and west-to-east directions, reversing direction at the end of each run by climbing straight ahead to about 200 ft above ground level (AGL), turning right about 80 degrees before turning left through 260 degrees and descending to the spray height to complete the next spray run. He commenced spraying at the northern edge of the paddock complex and was working to the south.

The mixer observed that the aircraft was higher over the crop than was normal for night spray operations and that the turns at the end of each spray run were very wide, suggesting to him that the pilot was operating conservatively. The marker said that the pilot was flying slowly and carefully. When the pilot advised over the radio that he had about 5 minutes of spray material remaining, the marker returned to the airstrip, picked up the mixer, and they drove around the perimeter of the airstrip, reactivating the runway lights. At about 2035, they heard a short, unintelligible radio transmission from the pilot, followed within a few seconds by a

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

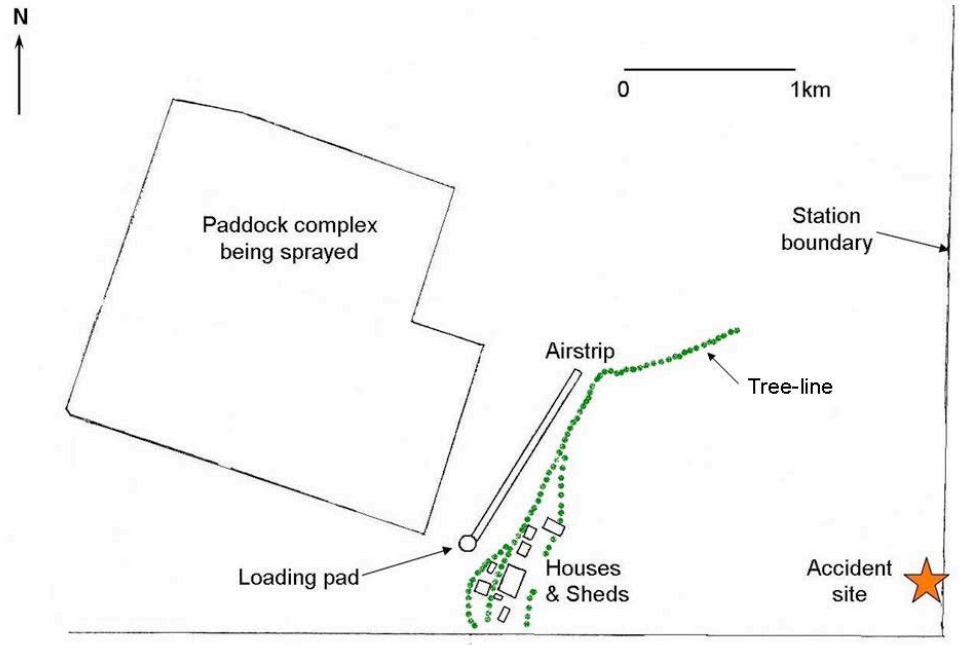
2 The mixer held an agricultural pilot licence, but did not hold a night rating. He was positioned at the airstrip loading pad, and was generally not in radio contact with the pilot.

loud thump and the cessation of aircraft engine noise[3]. The tone of the pilot's voice was loud, panicked and urgent, and the sound was described as a scream, a shout, or the sound of exertion. They then saw a glow to the east of the airstrip. When they arrived at the accident site, the aircraft was on fire, and the pilot was still strapped in his seat.

Wreckage information

The aircraft wreckage was located in a level paddock 2.7 km east of the Wynella airstrip and 3.6 km east-south-east of the eastern boundary of the paddock being sprayed (figure 1).

Figure 1: Wynella Station – south-east corner



The aircraft had impacted the ground in a wings-level, nose-low attitude, and heading approximately 030 degrees M (figure 2). There was no evidence that the aircraft had collided with any obstacles prior to impacting the ground.

The area south of Dirranbandi was sparsely populated and there was no ground lighting, other than the paddock and runway marker lights and the station lights. The station homestead and other buildings were located close to the airstrip and between the accident site and the airstrip. They were surrounded by large trees and any lights would have been largely obscured by these trees. The same line of trees may also have obstructed the pilot's vision of the paddock and runway edge marker lights.

3 The thump sound (most likely the sound of the aircraft colliding with the ground) was heard at the airstrip nearly 8 seconds after it occurred due to the speed of sound in air. Radio waves travel at the speed of light, so the radio transmission was heard at the airstrip at effectively the same time as the transmission was made.

There was no evidence that the aircraft was banked, slipping, yawing or rolling at impact. Almost all detached components of the aircraft were located in close proximity to the main wreckage. One propeller blade had separated at impact and was located 112 m from the main wreckage. All control surfaces were located at the accident site. The aircraft came to rest virtually at the point at which it impacted the ground.

The wing flaps were retracted, and the elevator trim wheel was in a slightly nose-up position. Flight control cable continuity was established between the flight controls and the cockpit area. Post-impact fire destroyed the cockpit and inboard sections of the wings, including most of the instrumentation and the connections between the flight control cables and the control stick and rudder pedals. Damage to the engine and propeller indicated that the engine was delivering power to the propeller at the time of impact.

Examination of light filaments from the aircraft's lights showed that the left turn light was illuminated at impact. Laboratory examination of the airspeed indicator showed that the airspeed at impact was approximately 115 kts, which was consistent with calculations of the aircraft's impact ground speed based on the spacing of propeller ground scars.

No pre-impact anomalies of any of the aircraft systems or engine were identified during the wreckage examination.

Figure 2: Accident site and aircraft wreckage

Aircraft information

Manufacturer	Air Tractor Incorporated
Model	AT-802A
Serial Number	802A-0085
Year of manufacture	1999
Hours in service	1,696.7[4]

The aircraft was fitted with two taxi lights, two turn lights, and two landing lights for ground illumination during night operations.

The taxi lights were fitted to the nose of the aircraft, immediately below the propeller hub, and the retractable landing lights were located on the outboard lower surface of each wing. Those lights provided forward illumination.

The turn lights were located on the end of each wing, and provided illumination angled forward of the lateral axis of the aircraft. They were intended to assist the pilot during turns at night by illuminating the ground when the aircraft was banked and below about 150 ft AGL. The turn lights were activated by a push-button switch on the pilot's control stick and selected by a three-position switch also located on the control stick. The selector switch could be positioned left, centre/off, or right.

The landing lights could not be illuminated if either of the turn lights was illuminated. The operator instructed his pilots not to use the taxi lights during normal operations as the landing lights provided sufficient forward illumination. The radio push-to-talk switch was also located on the control stick.

Weather information

Infrared satellite imagery showed a band of cloud associated with an upper level trough over Wynella at the time of the accident. Weather radar records indicated that there was no precipitation in the area. Witnesses at the site confirmed that it was cloudy at the time of the accident. The end of civil twilight[5] was 1937, the end

4 At the last annual inspection on 14 November 2004.

5 With no moon, artificial lighting, or adverse atmospheric conditions, large objects can be seen, but no detail is discernible. According to the Aeronautical Information Publication (AIP), the end of civil twilight is last light, after which time flight operations must be conducted under the rules applicable to night flight. The AIP also states that the presence of cloud cover will result in last light occurring earlier than it would have had the sky been clear of cloud.

of nautical twilight[6] was 2010, and the end of astronomical twilight[7] was 2044. There was no moon.

Pilot information

The pilot held a commercial pilot (aeroplane) licence, which was issued in 1998, and held an Ayres Turbo (PT6) aircraft class endorsement, which included the Air Tractor AT-802 aircraft. He was issued with a grade 2 agricultural rating on 27 July 1999, and a grade 1 agricultural rating on 3 December 2004. The pilot held an operational approval for aeroplane mustering. He had been issued with a night visual flight rules (VFR) rating on 21 February 2002 and a night VFR agricultural rating on 3 December 2004.

The pilot's night VFR agricultural rating training was conducted in Cessna 185 and 188 aircraft near Moree, NSW. The training included 5 hours dual night flight and 5 hours solo night flight[8]. The pilot's flight experience (including the accident flight) was as follows:

Total flight hours	3,317.7 hrs
Total night hours	33.2 hrs
Total command night hours	13.5 hrs
Total agricultural operations	1,140.4 hrs
Total night agricultural operations	1.9 hrs
Total Ayres Turbo (PT6) aircraft class experience	About 300 hrs
Total Air Tractor AT-802 experience	About 62 hrs

The pilot held a class 1 medical certificate valid until 20 May 2005. His most recent medical examination was conducted on 13 May 2004. During that examination, the pilot's blood pressure was 160/96, which was slightly above the maximum blood pressure stipulated on the Civil Aviation Safety Authority's *Medical Questionnaire and Examination Form*. The examining doctor arranged for the pilot to wear a portable blood pressure monitoring device for 24 hours. The results indicated that the pilot's blood pressure was normal, but that it was above the maximum due to

6 At the end of nautical twilight, under good atmospheric conditions and in the absence of other illumination, general outlines of ground objects may be distinguishable, but detailed outdoor operations are not possible, and the horizon is indistinct (US Naval Observatory).

7 At the end of astronomical twilight, the sun does not contribute to sky illumination, and the sky is sufficiently dark to allow sensitive astronomical observations.

8 Civil Aviation Order 40.2.2 Appendix II required that an applicant for a night VFR agricultural rating demonstrate his or her ability to safely control the aircraft using visual cues at night during take-off, low level circuit, landing, baulked approach, procedure turn and simulated spraying runs. The applicant was also required to demonstrate safe control of the aircraft solely by reference to instruments and within the tolerances specified during straight and level flight, climbing and descending, climbing and descending turns, steep turns, and recovery from unusual attitudes.

'white-coat effect'[9]. The results from a blood test during May 2004 indicated that his total cholesterol and low-density cholesterol were above the maximum limit specified by the pathology organisation[10].

The Civil Aviation Safety Authority (CASA) established the likelihood of a cardiac event for individuals using the *Coronary Heart Disease Risk Factor Prediction Chart*. If the risk of a cardiac event was greater than 10% within 10 years, CASA required further medical assessment. The pilot's cardiac event risk was up to 9% within 10 years (depending on which systolic blood pressure value was used), slightly less than the minimum threshold for further assessment stipulated by CASA.

Post-mortem examination of the pilot identified severe atherosclerotic narrowing of all three coronary arteries, evidence of prior interruptions of oxygen supply to the heart, and indications that blood pressure was maintained for a very short period after impact. There was no evidence of a recent heart attack[11], or that the pilot had inhaled smoke.

Toxicological testing identified a trace quantity of diazepam[12], a psychotropic medication which was not compatible with aviation operations. The effect on the pilot's performance, if any, of a trace amount of diazepam was likely to be insignificant, but could not be conclusively established. The pilot's next of kin were not aware of any medicine that contained diazepam that had been prescribed for the pilot.

The pathologist concluded that the pilot died of multiple injuries, with coronary atherosclerosis as a secondary finding.

Organisational information

The night spraying operation was being conducted under the night visual flight rules[13], which meant that the pilot's primary means of orientation was through external references such as the horizon, terrain illuminated by ambient light and by the landing and turn lights, and the marker lights. Instrument reference should have been reserved for maintaining control of the aircraft should visual reference be lost, confirming visual indications of aircraft orientation, and aligning the aircraft with the spray run (using the GPS equipment in the aircraft).

The chief pilot reported that he had instructed the pilot that if he ever became unsure of his position or attitude during night operations, he should level the wings

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9 A colloquial term to describe the phenomenon of an elevated blood pressure in a clinical setting, but a normal blood pressure outside that setting. It is believed that this effect is due to the anxiety some people experience during a clinic visit.

10 CASA used blood cholesterol levels in the assessment of cardiac event risk, but it did not specify maximum blood cholesterol levels.

11 A heart attack immediately prior to the accident would not leave any evidence in the heart tissue.

12 Marketed under various brand names including Valium.

13 Issues related to flight operations under the night visual flight rules have been addressed in various ATSB reports, including *200100348 Cessna 310R VH-HCP Newman WA 26 January 2001* and *200304282 Bell 407 VH-HTD Cape Hillsborough Qld 17 October 2003*.

and establish the aircraft in a climb, and subsequently confirm that the vertical speed indicator showed a positive rate of climb. The chief pilot also stated that there was no pressure on the pilot to complete the spraying operation that night.

The mixer reported that immediately prior to the accident flight, he advised the pilot that there was no pressure to continue spraying, and that if the lights went out or he had any problems, he should fly to the operator's base at Mungindi aerodrome, and return the following morning to complete the spray operation.

ANALYSIS

During a night spraying operation, the aircraft collided with terrain in a nose-low, wings-level attitude. This analysis identifies a number of safety factors which may have contributed to the development of the accident.

Witness information and the wreckage examination indicated that the aircraft engine and some external lighting systems were functioning at the time of impact. Post-impact fire damage of the cockpit area meant that the investigation could not conclusively rule out other forms of mechanical malfunction such as flight control or instrument failure as contributing to the accident.

The pilot had substantial agricultural and general flying experience, but had only recently completed his night agricultural rating training, and consequently had minimal experience in night agricultural operations.

The location of the accident site and the aircraft's heading at the time of impact was consistent with the aircraft being either in a wide procedure turn for an east-to-west spray run, or a wide downwind leg of a landing approach. Therefore, it is not clear whether the pilot, immediately prior to the accident, was positioning the aircraft for another spray run, or for a landing.

The lack of any evidence of bank or slip at impact could suggest that the aircraft pitched down during straight flight and maintained the nose-low pitch attitude until impacting the ground. While a reversal procedure at the end of each spray run would not normally include any straight flight until established in the direction of the spray run, in some circumstances the pilot may have established the aircraft in straight flight, such as to intercept the inbound spray run track. The aircraft would also have been in straight flight if it was on a downwind leg for a landing. The illuminated left turn light suggests the pilot may have been anticipating a turn to the left during manoeuvring for a spray run.

Irrespective of the phase of flight of the aircraft immediately prior to impact, it is unlikely that the pilot intended to allow the aircraft to descend. With minimal external visual references, and at such a low height, to deliberately pitch down would be an extremely high risk manoeuvre, and contrary to the chief pilot's instructions.

The pilot may have inadvertently allowed the aircraft to descend while his focus was elsewhere, such as looking out for the marker lights or manipulating the GPS system. With no moon, other celestial illumination obscured by cloud, and minimal ground lighting, the night was quite dark. In these conditions, there would have been virtually no external visual cues available to the pilot that would have indicated that the aircraft had started to descend. Other cues, such as instrumentation indications and increased airflow noise may not have been sufficiently obvious to alert the pilot, particularly if his attention and concentration was focussed elsewhere. In this case, the short radio transmission may have been a consequence of the pilot becoming aware of the imminent impact.

The night spraying operation at Wynella was not straightforward, given the pilot's lack of familiarity with the station, his inexperience in night agricultural operations, the absence of celestial illumination, and the absence of substantial ground lighting. That the pilot did not feel comfortable or confident about conducting the night flight is confirmed by the recollections of the mixer and marker, the wide reversal

turns, his increased spray height, and the reduced speed at which he was operating. The effect of the pilot's decision to conduct procedure turns higher and wider than normal was to increase his distance from the available ground lighting and reduce the effectiveness of the aircraft turn lights.

It is possible that the pilot was incapacitated by a cardiac event. The extent of coronary artery disease affecting the pilot indicated that a cardiac event was possible. If the pilot experienced a cardiac event, involuntary reactions could have resulted in forward pressure on the control stick, the activation of the radio push-to-talk switch, and a voice tone that sounded like a scream or a sound of exertion. The initiation of an incapacitating cardiac event could have resulted from his perception of the risks of operating in the dark conditions with little operational experience in those conditions.

The lack of recorded and witness information, and the destruction of the cockpit by fire, prevented the investigation from conclusively identifying the factors that contributed to the development of the accident. However, the combination of pilot inexperience in night agricultural operations and the dark conditions increased the risk of an accident. The systematic and comprehensive identification of potential risks in any activity by those involved, including operators, pilots and support staff, and the development of strategies to mitigate the identified risks, can reduce the likelihood of an accident.

CONCLUSIONS

Contributing safety factors

1. The aircraft collided with level terrain in a nose-low, wings-level attitude.

Other safety factors

1. The pilot was inexperienced in night agricultural operations.
2. There was minimal ground and celestial lighting available to assist the pilot in maintaining external visual reference.
3. Post-mortem examination identified severe coronary heart disease.