Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2008-014
Final

Midair collision
10 km NE of Wee Waa, New South Wales
26 February 2008

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VH-CJK, Air Tractor 502
VH-ATB, Air Tractor 502B

Published by:	Australian Transport Safety Bureau
Postal address:	PO Box 967. Civic Square ACT 2608
Office location:	62 Northbourne Ave, Canberra City, Australian Capital Territory, 2601
Telephone:	1800 020 616, from overseas +61 2 6257 4150
	Accident and incident notification: 1800 011 034 (24 hours)
Facsimile:	02 6247 3117, from overseas +61 2 6247 3117
Email:	atsbinfo@atsb.gov.au
Internet:	www.atsb.gov.au

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Prepared By

Australian Transport Safety Bureau
PO Box 967, Civic Square ACY 2608 Australia
www.atsb.gov.au

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Figure 1: Courtesy of Google Earth
Figure 2: Courtesy of Air Tractor Inc.

Abstract

At about 0930 Eastern Daylight-saving Time on 26 February 2008, an Air Tractor Inc. 502, registered VH-CJK (CJK) that was aerial spraying 10 km north-east of Wee Waa, New South Wales and an Air Tractor Inc. 502B, registered VH-ATB (ATB) that had just departed from a nearby airstrip, collided at about 200 ft above ground level. The pilot of CJK was fatally injured and the pilot of ATB was seriously injured. Both aircraft were seriously damaged. Neither pilot was aware of the other aircraft and, although visibility at the time of the accident was reported as ‘good’, either one or both pilots did not see the other aircraft in sufficient time to avoid a collision.

The limitations of an unalerted visual traffic scan could explain why both pilots may not have seen the other aircraft but, without the knowledge of one another’s intended operations they lacked situational awareness. Generally, agricultural pilots relied on visual separation and vertical segregation to avoid collisions. In this instance, the proximity of the field being sprayed to the airstrip from which ATB took off and the aircraft’s climb gradient from that airstrip, brought the two aircraft into conflict.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

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 identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, 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 initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

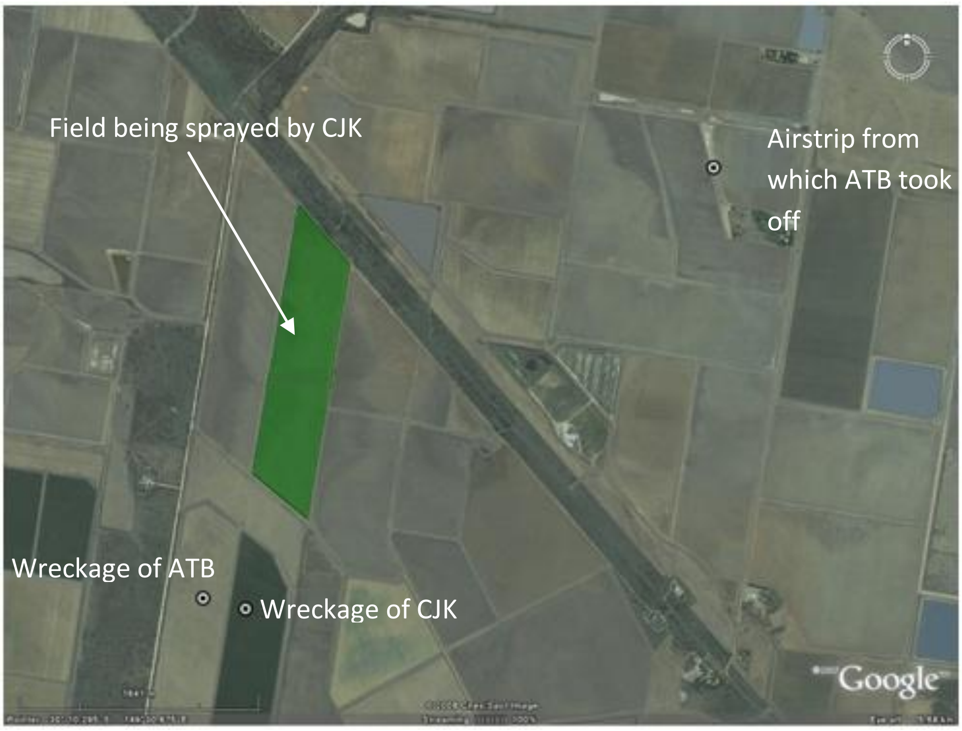
FACTUAL INFORMATION

Sequence of events

At about 0928 Eastern Daylight-saving Time[1] on 26 February 2008, the pilot of an Air Tractor Inc. 502B, registered VH-ATB (ATB), departed from an airstrip about 13 km north-east of Wee Waa township, New South Wales. The flight was the second that morning to apply herbicide to a crop of sorghum on a property that was located 10 km south-west of Wee Waa. At the time, the pilot of an Air Tractor Inc. 502, registered VH-CJK (CJK), was spraying insecticide on a crop of mung beans in a field about 3km south-west (10 km north-east of Wee Waa township) of the airstrip. Both aircraft were operating under the visual flight rules (VFR).

At a location just south of the field that was being sprayed by CJK (about 9 km north-east of Wee Waa township), the two aircraft collided in mid air, and crashed into adjacent fields (Figure 1). The pilot of ATB was seriously injured and the aircraft was seriously damaged[2] by collision forces with the other aircraft, ground impact, and a post-impact fire. The pilot of CJK was fatally injured and the aircraft was seriously damaged by collision forces and by ground impact. It did not catch fire.

Figure 1: Satellite image of accident location



[1] The 24-hour clock is used in this report to describe the local time of day, Eastern Daylight-saving Time (EDT), as particular events occurred. Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.

[2] The Australian *Transport Safety Regulations 2003* definition of 'serious damage' included the destruction of the transport vehicle.

The crops in the respective ground impact areas were damaged by chemical and fuel spill in the vicinity of the wreckages. Additionally, some vegetation around the wreckage of ATB was burnt due to the post-impact fire, and other vegetation was flattened by rescue personnel in the process of accessing the respective accident sites.

The pilot of ATB later reported that he was climbing to his usual transit height of between 500 ft and 600 ft above ground level (AGL) at 90 KIAS[3] and was about 300 ft AGL when the impact occurred. He had not sighted any other aircraft, and was unaware at the time that his aircraft had collided with another aircraft. He had no recollection of subsequent events.

The loader[4] who was employed by the pilot of ATB, recorded the aircraft's take-off and landing times. Those records showed that at 0847 the pilot of ATB departed for the treatment area on his first flight that day, and that he returned at 0918.

At 0850[5], the pilot of CJK took off from the Wee Waa airstrip, which was 4.5 km south-west of Wee Waa. The flight was his first to the application area near where the accident occurred. He landed back at Wee Waa airstrip at 0914 to uplift the second load of chemical.

The two pilots were unaware of each other's operations and their respective application areas, as operators did not normally advise each other of their intended task areas. The pilot of ATB had not seen CJK and it was not known if the pilot of CJK had seen ATB while transiting to the application area.

At 0919, the pilot of CJK took off for the second flight and had been spraying the treatment area for about 4 minutes when ATB commenced its takeoff. During the time that CJK was in the treatment area, ATB was on the ground while its pilot and loader replenished the aircraft with fuel and loaded the chemical. The loader recorded ATB taking off at 0928.

Witness information

A farmer who was about 2 km west of where the collision occurred, reported that he had stopped his tractor to remain clear of any spray drift and watched CJK for several minutes as it made reciprocal spray runs, oriented north-south, over the application area. The aircraft was partially obscured behind trees during the spray runs due to its low level, but was clearly visible during the procedure turns[6] at either end of the application area. He reported that the height of the turns was consistent, and that CJK had pulled up from a north-to-south spray run and was making a left turn at the time of the collision. He reported that he did not see the actual collision, but saw a ball of fire in the air and then two aircraft diving to the ground. One aircraft was on fire. They disappeared from his view behind an intervening tree line,

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3 Indicated airspeed, expressed in knots.

4 Term used to denote ground support personnel whose functions include assisting with mixing chemicals, and loading and dispatching the aircraft.

5 Times recorded by the satellite tracking device in CJK. The accuracy of the time-base could not be verified exactly with the local time of day.

6 The manoeuvre used at the end of a swath or, in this case spray run to reverse the direction of flight and align the aircraft for the next swath run in a reciprocal direction.

but a column of smoke arose from where one of the aircraft collided with the ground.

Two farm workers who were about 1.5 km west of the airstrip from which the pilot of ATB took off, saw the aircraft depart normally. A short while later, they saw smoke in the area of the accident site and, suspecting that the aircraft had crashed, made their way to the area.

Several other people working on nearby farms or driving along adjacent roads reported hearing or briefly seeing CJK, but because of the prevalence of aerial spraying in the region, none had watched the aircraft for any length of time and did not see or hear the collision.

Rescuers attending the accident scene initially thought that only a single aircraft was involved. They reported that the aircraft was on fire and that the pilot of ATB was seen standing some distance from the aircraft and waving to them. They spoke to him, but he was not aware there had been a midair collision. After realising that another aircraft had been involved, rescuers made their way to the wreckage of CJK. During their attempts to release the pilot from the upturned wreckage, ambulance personnel arrived and established that the pilot had been fatally injured.

The loader who was employed by the pilot of ATB, reported that he and the pilot were at the airstrip from 0730 that morning. After ATB departed, he remained at the airstrip and prepared the next load and was not aware of another aircraft spraying a nearby field. During the turnaround between flights, the pilot of ATB kept the engine running for the entire time that the aircraft was on the ground. The loader pumped chemical into the aircraft's hopper while the pilot refuelled. The loader stated that, with their attention directed to their respective tasks, they had not seen the other aircraft and that normally the sound of another aircraft operating nearby would have been clearly audible. He recalled that on this occasion, the noise of ATB's engine and the chemical pump masked the sound of the other aircraft.

Personnel information

Pilot of ATB

Type of licence	Commercial Pilot (Aeroplane) Licence, issued on 17 September 1993
Medical certificate	Class 1, valid until 8 November 2008 (no restrictions)
Ratings	Agricultural Grade 1, issued on 7 January 1997
Endorsements	Ayers Turbo (PT6)
Flying experience (total hours)	8,875[7]
Hours on type	6,000[7]
Aeroplane flight review	25 September 2007
Hours flown in the last 24 hours	3.5[7]
Hours flown in the last 90 days	94.0[7]
Hours on duty	2.5[7]

The pilot of ATB was an experienced agricultural pilot who was based in the Wee Waa district. More than half of his total aeronautical experience was in aerial agricultural operations.

The pilot reported that, on the day before the accident, he had flown four or five loads and that, 2 days before that, he had worked between 4 and 5 hours. He reported that he was well rested and in good health.

7 Times were provided by the pilot and in some cases were estimates.

Pilot of CJK

Type of licence	Commercial Pilot (Aeroplane) Licence, issued on 8 April 1971
Medical certificate	Class 1, valid until 25 March 2008 Restrictions: Distance vision correction to be worn during flight and reading correction to be available during flight
Ratings	Agricultural Grade 1, issued in1973
Endorsements[8]	Ayers Turbo (TPE 331)
Flying experience (total hours)	14,083.0
Hours on type	1,085.9
Aeroplane flight review	31 October 2007
Hours flown in the last 24 hours	1.0
Hours flown in the last 90 days	299.3
Hours on duty	Unknown (estimated based on witness statements to be less than 2)

The pilot of CJK was a very experienced agricultural pilot who was also based in the Wee Waa district. Nearly all of his total aeronautical experience was accrued in aerial agricultural operations over a period of more than 35 years.

The pilot's activities for the days preceding the accident were not fully known. Colleagues and friends reported that the pilot exercised regularly and appeared to be in good health. The pilot had reported feeling tired on a few occasions during the previous few months when there had been greater flying activity.

It could not be determined if the pilot was wearing prescription glasses on this flight.

Aircraft information

Both aircraft were single-seat agricultural aircraft that were manufactured in the United States (US) by Air Tractor Inc. The AT 502 (Figure 2) and AT 502B were powered by a single Pratt and Whitney Canada PT-6A-15AG turboprop engine, which was rated at 680 shaft horsepower (shp) (maximum continuous power) and drove a three-blade Hartzell propeller.

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8 Civil Aviation Safety Authority records for the pilot only recorded an endorsement for the Ayers Turbo (TPE 331) aircraft type, dated 17 November 2003. A Certificate of Type Endorsement for the Turbo Thrush/Air Tractor (that included the Ayers Turbo (PT6) aeroplane) dated 13 November 1996 was found with the pilot's personal documents.

Figure 2: Air Tractor Inc. 502 aircraft similar to ATB and CJK

Both aircraft were painted bright yellow. The only significant difference between the two paint schemes was the colour of the stripes along the fuselage, tail and wing tips. The stripes on CJK were green and on ATB they were blue. Both aircraft were equipped with wingtip strobe lights and a red flashing beacon.

ATB

Manufacturer	Air Tractor Inc.
Model	AT-502B
Serial Number	502B-0287
Year of manufacture	1995
Certificate of registration (Initial)	Issued: 7 February 1996
Maintenance release	Not found[9]
Total time in service (TTIS)	5,478.4 hours (estimated[10])
Allowable take-off weight	4,272 kg
Actual take-off weight	4,451.6[11] kg
Weight at occurrence	4,437.6 kg
Allowable centre of gravity (c.g) limits	16 to 28 in. Aft of datum
Centre of gravity at occurrence	Not known

9 The Maintenance Release was not recovered from the fire-damaged wreckage.

10 This figure represents the TTIS at the previous maintenance inspection plus the pilot's recorded flying times on the aircraft since.

11 Agricultural aircraft operated in the RESTRICTED category and were authorised to take off at weights greater than the certified maximum allowable take-off weight.

The pilot reported that the aircraft had no defects and that the takeoff and climb were normal. The aircraft had full fuel and a load of about 1,700 L of chemical in the hopper.

A very high frequency (VHF) radio that was capable of transmitting on aeronautical frequencies was installed in the aircraft. An ultra high frequency (UHF) radio that was capable of transmitting on the citizen band frequencies was also installed in the aircraft.

The pilot reported that the aircraft's flashing beacon always remained on, but the strobe lights were only used in darkness or in conditions of poor visibility, as they were ineffective in normal daylight.

CJK

Manufacturer	Air Tractor Inc.
Model	AT-502
Serial Number	502-0057
Year of manufacture	1989
Certificate of registration (Initial)	Issued: 26 Oct 1989
Maintenance release	Not located
Total time in service (TTIS)	7,961.3 hours
Allowable take-off weight	2,954 kg
Actual take-off weight[12]	3,550.5 kg
Weight at occurrence[12]	3,523.5 kg
Allowable centre of gravity(c.g) limits	16 to 28 in. Aft of datum
Centre of gravity at occurrence	Not known

It was not known if the aircraft displayed any strobe lights or an aircraft beacon at the time of the accident. The strobe lights switch was found in the central, OFF position but may have been moved during the accident sequence or when the rescuers were retrieving the pilot from the wreckage.

The aircraft was not equipped with a VHF radio, nor was there any requirement for the carriage and use of radio in aircraft operating under the VFR in class G airspace[13] in the Wee Waa area. The operator advised that radio communication was not mandatory for the areas where his aircraft operated and cited reduced aircraft maintenance as the reason for not equipping his aircraft with VHF radios. A UHF radio was also installed in the aircraft.

A pilot, who had flown the aircraft earlier that morning, reported that there were no known defects with that aircraft.

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12 Assuming that the aircraft's fuel tanks were filled prior to the first flight.

13 The airspace in the area around Wee Waa below flight level (FL) 180 is classified as class G (non-controlled) airspace.

Visibility from the cockpit

The configuration of an aircraft and the cockpit can impose limitations on the visibility available to the pilot. That visibility is interrupted by obstructions such as window pillars, equipment installations such as the satellite navigation light bar[14] mounted ahead of the windshield, and external features such as the aircraft's wings. All can result in blind spots or limit the pilot's vision to one eye only (monocular vision).

Cockpit visibility from an Air Tractor 502 provided an almost 360° view for the pilot and the raised, mid-fuselage cockpit (a design feature typical of most agricultural aircraft) afforded a pilot a good forward view. Pilots reported that even in a climb attitude, the nose of the aircraft would not obscure the horizon. Either side of the aircraft's nose, the forward view was unobstructed to the leading edge of each wing (Figure 3).

The windshield consisted of a central glass panel, either side of which was a transparent quarter panel that was constructed of curved, acrylic plastic. The four windshield pillars and the light bar in the Air Tractor 502 were the only obstructions to the pilot's forward visibility.

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14 Term used to describe the visual display, consisting of a series of lights and numerals that formed part of the SATLOC satellite navigation system.

Figure 3: View from Air Tractor cockpit

Left wing Instrument panel Right wing

Composite photograph depicting a pilot's view from the cockpit of an Air Tractor AT-502 in the three-point attitude (similar to the climb attitude)

Meteorological information

The pilot of ATB reported that the weather conditions at the time of the accident were clear, with bright sunshine and good visibility. The wind at the airstrip was reported to be about 3 to 6 kts from the north-north-east and the flying conditions smooth. Another pilot who was flying in the Wee Waa area that morning gave a similar description of the weather conditions.

Astronomical information obtained from the Geoscience Australia web page showed that at the time of the collision, the sun's azimuth was bearing 080° from True North and that the sun subtended an angle of 33.5° above the horizon at ground level.[15]

Data from the automatic weather station at Narrabri aerodrome (40 km south-east of the accident site) at 1000 that morning recorded a wind of 11 kts from a direction of 021º True (T) and a temperature of 26 ºC.

Aids to navigation

Each aircraft was fitted with a SATLOC satellite navigation system that provided accurate tracking guidance for swath runs during aerial application. The tracking guidance was displayed on a light bar that was mounted ahead of the aircraft's instrument panel. The pilot of ATB reported that he frequently monitored the light bar during swath runs and throughout the procedure turns, but did not use it to navigate to or from an application area.

Communications

The pilot of ATB reported that the VHF radio in his aircraft was tuned to the multicom[16] frequency of 126.7 MHz, but he had not made any positional broadcasts on that frequency that morning. The use of radio communication for air traffic broadcasts was limited to those locations where the carriage and use of radio was mandatory. That did not include in the area of the accident.

The UHF-band frequencies were categorised as channels. Each operator and property owner used an assigned channel for communication in relation to the operation of their business. Pilots reported that they used the company-assigned channel to communicate with ground personnel about operational matters. At times, if they saw another aircraft while flying to or from an application area, they would establish communication with the other pilot via UHF if they recognised the operator's aircraft. That was described as merely a courtesy, and was not normally used to establish separation between operations. They reported that the competitive nature of aerial agriculture meant that pilots were guarded about communicating the location of their application areas in order to protect the confidentiality of their clientele.

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15 See http://www.ga.gov.au/geodesy/astro/

16 The frequency used for broadcasts while operating to or from a non-towered aerodrome that does not have a discrete common traffic advisory frequency assigned.

As was the usual practice, the UHF radios in both aircraft were reported to be tuned to their respective operator's discrete channel for communication between the pilots and their respective ground support personnel. The pilot of ATB reported that he used the UHF radio on the first flight to advise his loader that he was returning for the next load. The pilot of CJK was reported to have contacted that operator's ground personnel on the company UHF channel during his first flight that morning to advise that as conditions were suitable for spraying, he would be taking the next load of chemical for the second flight.

Additionally, both pilots carried mobile telephones. The pilot of ATB reported that a mobile telephone was an essential in-flight communications tool, and that he had intended integrating a mobile phone into the aircraft's audio system to permit telephone communication through the helmet-mounted earphones and microphone. However, he reported that he experienced difficulties with the mobile telephone coverage and that as a consequence, he had deferred the completion of the installation. The mobile telephone that was carried by the pilot of CJK was not integrated into the aircraft's avionics system.

A check of mobile telephone records showed that there was no recorded activity for either pilot's mobile phone at the time of the collision.

Aerodrome information

The airstrip where ATB was based and operated from consisted of a level runway that was about 750 m long and aligned 350/170° T (runway 35/17). The threshold of runway 17 and two-thirds of the runway length was sealed. The office, hangar and loading bay were at the northern end of the airstrip and immediately east of the runway. To avoid prolonged taxiing, takeoffs were usually made to the south and landings into the north.

Wreckage and impact information

The main wreckage of each aircraft was located 300 m apart in fields separated by an irrigation channel and an access road. Items of wreckage were scattered between the two aircraft wreckage sites and orientated in a north-east to south-west direction. Although the fields into which the aircraft crashed were level, the soft, irrigated soil and the closely planted crops made access to both aircraft difficult for rescuers. The dense vegetation and soft soil precluded the recovery of some damaged components from the wrecked aircraft.

Wreckage of ATB

The wreckage of ATB was lying in a soy bean crop that stood nearly 1.2 m high. A localised, intense post-impact fire destroyed part of the aircraft's structure and the immediate environment. A chemical spill of Glyphosate herbicide from the aircraft's ruptured hopper contaminated some of the surrounding crop. The chemical was not classified as a hazardous material.

The main aircraft wreckage was inverted and fire had consumed the inboard section of the left wing, the centre fuselage section and much of the cockpit area (Figure 4). The right wing had been torn into two pieces, with the top cap of the front spar holding the outboard section of the wing to the fuselage. The horizontal stabilisers and elevators remained integral with the fuselage and exhibited ground impact damage. The left main landing gear was attached to the airframe, but the right wheel and gear leg had separated. The engine and propeller were attached to the fuselage and displayed evidence of power being produced at the time of the impact with the ground.

The inboard sections of the right wing and wing flap were found along the wreckage trail in the direction of the wreckage of CJK. The fin of ATB was destroyed but the rudder remained attached to the aircraft by its control cables. The top panel of the fibreglass hopper and lid actuating mechanism and other components from ATB were found 100 m back along the wreckage trail. That damage was consistent with separation as a result of the midair collision.

The pilot reported that the aircraft had been operating normally prior to the collision.

Figure 4: Wreckage of ATB

Wreckage of CJK

The wreckage of CJK was lying in a 600 mm high crop of mung beans (Figure 5). The site was contaminated by a chemical spill from the ruptured hopper, and by aviation turbine fuel. The chemical (Alpha-Cypermethrin) was classified as a Group 3A insecticide, and access to the site required full protective covering for a period of 48 hours after spillage.

The main wreckage came to rest inverted with both wings detached from the fuselage. The flap screw jack was extended 60 mm indicating that some flap was extended at ground impact. The right wing was intact and had sustained high velocity, vertical impact damage along its entire leading edge. The left wing was pushed rearward and was missing the outboard section. The left side of the fuselage, adjacent to the cockpit, sustained considerable damage from ground impact forces.

Figure 5: Wreckage of CJK

The right landing gear leg was with the main wreckage, but the wheel had detached on impact with the ground and was lying behind the wreckage. The engine and propeller had detached from the fuselage during the collision with the ground and came to rest about 10 m from the main wreckage. Examination of the engine indicated that it was producing power at the time of impact with the ground and there was no evidence of any pre-existing defects.

The separated section of the left wing was found about 80 m from the main aircraft wreckage, toward the wreckage of ATB. The left horizontal stabilizer displayed high-energy damage to its tip and the left elevator had been torn from its torque tube. The left landing gear had separated from the aircraft and was found about 60 m from the main wreckage, beside a deep furrow that marked its initial impact with the ground. Fragments of unpainted fibre glass were found imbedded in the wheel and tyre. Damaged sections of the spray booms[17] and other components from ATB were scattered along the wreckage trail. Damage to the liberated items was consistent with separation as a result of the midair collision.

[17] The spray boom included the tubing and nozzles arranged spanwise below the trailing edge of the aircraft's main wing for aerial application of chemicals.

Medical and pathological information

Pilot of ATB

The pilot of ATB was seriously injured and received treatment in hospital for full thickness burns to his legs and bruising and lacerations to his head, limbs and body.

Pilot of CJK

Post-mortem examination of the pilot of CJK found that the injuries sustained were consistent with an extreme impact. It was not possible to determine if some of the pilot’s injuries were received in the collision with ATB or during ground impact. Abrasions to the pilot’s body were consistent with those formed by the straps of a four-point harness.

The post-mortem and toxicological examinations found no evidence that physiological factors affected the performance of the pilot, or that the pilot was incapacitated prior to the collision with ATB.

Fire

Examination of the wreckages of both aircraft revealed sooting on damaged components, consistent with an in-flight fuel or chemical flash fire following the midair collision. The cockpit area of the fuselage and the inboard section of the left wing of ATB were seriously damaged by an intense, fuel-fed fire that followed its collision with the ground.

There was no fire damage to CJK.

Survival aspects

Survivability - ATB

Air Tractor ATB impacted the ground on its right main wheel before tumbling and coming to rest inverted. The pilot could not remember how he exited from the wreckage. Rescuers reported that, on their arrival at the accident scene, the pilot was walking around, burnt and injured at some distance from the main wreckage of the aircraft.

The aircraft’s protective structure around the cockpit remained intact, allowing a survivable space for the pilot. The pilot’s seat mounts had failed and the lower straps of the pilot’s four-point harness were burnt, leaving only their attachment points. The buckle and buckle-end fittings were destroyed in the fire. The upper restraint straps were found lying near the wreckage. Their buckle-end fittings were undamaged, but the webbing had been torn from their airframe attachments. There was no fire damage to those straps.

The pilot’s helmet was found in the cockpit and had been burnt.

Survivability - CJK

Due to the attitude of CJK when it impacted the ground, the left side of the fuselage was deformed, breaching the integrity of the aircraft's protective structure around the cockpit. The attachments for the pilot's four-point harness were intact and the webbing of both the upper and lower restraint straps had been cut by rescuers attempting to free the pilot. The buckle was still fastened correctly. The seat was correctly attached to the airframe, but the fuselage's tubular steel frame had buckled under the extreme forces generated during the collision with the ground.

The pilot's helmet was nearby and intact, with the chin straps in their stowed position.[18]

Organisational and management information

Aerial agricultural-specific operations

There were at least three aerial agricultural operators based around Wee Waa. Each operated from a different airstrip and, while the majority of their clients were located in the immediate vicinity of their respective airstrips, it was not uncommon for operators to have application areas near another airstrip. Several pilots reported that when aerial application was planned immediately adjacent to another airstrip, they would contact the operator based at that airstrip and advise of their intended operation. Those pilots also reported that, unless they were operating immediately adjacent to another airstrip, they would not normally contact the operator at that airstrip to coordinate flying activity.

Aerial agricultural aircraft operations that were conducted in accordance with Civil Aviation Safety Regulations (CASR) Part 137 – *Aerial Application Operations, other than Rotorcraft,* effective 27 May 2007 were permitted to fly at any altitude over non-populated areas when conducting aerial application. That was also the case while transiting to and from an application area and to an airstrip used for loading.

Additionally, aircraft engaged in agricultural operations were exempted from compliance with a number of the requirements of Civil Aviation Regulation (CAR) 1988 CAR 166.[19] Normally, CAR 166 required a pilot who was taking off from a non-controlled aerodrome, like the airstrip at which ATB was based, to not turn below 500 ft AGL and to make all turns in the circuit direction (usually anticlockwise). The exemption permitted agricultural pilots to turn at 100 ft AGL and to turn left or right as required, contrary to the circuit direction. However, in such circumstances, pilots were required to broadcast their intention to do so on the local area frequency.

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[18] When the chin straps are not used they can be secured by clipping them into fairings on each side of the helmet to avoid entangling with helmet chords and clothing.

[19] Civil Aviation Orders (CAO), Section 20.21 – *Aircraft Engaged in Agricultural Operations*, para 7. During the transition to Civil Aviation Safety Regulations, Part 137 from 27 May 2008 to 27 May 2009, CAO 20.21 was still effective.

Segregation of agricultural operations

The primary means of separation for aircraft engaged in agricultural operations in Class G airspace in the Wee Waa area was unalerted see-and-avoid. Separation was a pilot responsibility that relied on pilots visually sighting other aircraft and avoiding them. To minimise the risk of collision with aircraft engaged in aerial application, agricultural pilots reported that the usual practice was to fly to the treatment area at or above 500 ft AGL to remain well above the working (spraying) aircraft, and to return from the treatment area at 800 ft to 1,000 ft AGL. That ensured that the returning aircraft remained clear of the working aircraft and of the aircraft flying to their respective application areas. In circumstances where that type of segregation was not possible, pilots reported that the safest flight path was across the centre of an application area, clear of the area where the working aircraft was pulling-up to make the procedure turns at either end of the spray runs.

Additional information

Limitations of see-and-avoid

In April 1991 the Bureau of Air Safety Investigation (BASI)[20] published a research report titled, *Limitations of the See-and-Avoid Principle*. That report analysed the physical and physiological factors that limited a pilot's effectiveness in visually detecting other aircraft, and included; workload and distractions, field of vision and blind spots, the pilot's visual scanning technique and its limitations, peripheral vision and lack of relative motion.

The report concluded that it was likely that the historically small number of midair collisions had been, in a large part, due to low traffic density and chance, as much as to the successful operation of see-and-avoid. It recommended that pilots should recognise that they cannot rely entirely on vision to avoid collisions and that they obtain traffic information from additional sources to enable a directed traffic search.

Visual traffic scan

To effectively scan the sky for other traffic, a pilot must adopt a systematic procedure to accommodate the limitations of the human eye. The eye cannot detect objects while sweeping and so must pause at intervals, and focus on that portion of the sky being examined, before moving on to the next area to be checked. The BASI report quoted estimates made by the US Federal Aviation Administration, which found that each fixation takes around 1 second and that, to scan an area of 180° horizontal and 30° vertical could take up to 54 fixations (or at least 54 seconds). That time has to be shared with other vital tasks to be performed when the pilot is not looking for other traffic.

Importantly, the situation is dynamic and changes even as the scan is in progress. Because of this, scans tend to be unsystematic, with those areas of potential traffic conflict receiving more attention and other areas neglected. For example, when

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20 The Bureau of Air Safety Investigation was the former aviation investigation agency in Australia prior to July 1999, when its functions were incorporated into the Australian Transport Safety Bureau (ATSB).

climbing a pilot would scan the area above the horizon more thoroughly for conflicting traffic than the area below the horizon.

Obstructions to vision

Windshield pillars, bug splatter and other objects create obstructions to vision even though they may not completely block binocular vision. Small objects which fall within a region of monocular visibility are less likely to be detected than similar sized objects when using both eyes. A secondary undesirable effect of these obstructions is that they can act as a focal trap for the eyes, drawing the point of focus inwards, and making it more difficult to see distant small objects.

Pilot workload during aerial application operations

A number of agricultural pilots reported that during low-level application, a pilot's attention was almost completely focussed on flying the aircraft accurately just above the crop, monitoring equipment, maintaining an accurate swath using the light bar and avoiding obstacles. At either end of the application area, the working aircraft would be pulled up to a height of between 200 and 300 ft AGL while making a procedure turn. During a procedure turn, a pilot's attention was divided between the aircraft's orientation and alignment for the next spray run. Maintaining a thorough lookout for other aircraft during that manoeuvre was reported to be extremely limited.

Mobile telephone use

Changing telecommunication technologies have significantly altered the way business is transacted. That technology has enabled aerial agricultural operators to be contactable by mobile phone at any time, including while airborne. The use of mobile telephones for non-aviation-related communication could present an unacceptable distraction, affecting lookout, and increasing the risk of collision to both the pilot and to other airspace users.

Studies have been made to determine the distraction to motorists from the use of mobile phones while driving.[21] Those studies showed a significant correlation between the use of mobile phones, including 'hands-free' phones, and the degree of distraction. Although there have been no aviation-specific studies on this subject, there do not appear to be any sound reasons why these conclusions would not apply equally to pilots during most phases of flight.

Recorded information

Each aircraft's SATLOC satellite guidance system recorded in-flight data to a memory flashcard. That data included the aircraft's track, speed, and altitude, and the time and spraying information.

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21 Young K, Regan M, Hammer M, 2003 *Driver Distraction: A Review of the Literature*, Monash University Accident Research Centre.

The memory flashcard from CJK contained data for about 8 minutes 25 seconds of the flight, but did not include the last two spray runs, an estimated 1 minute and 44 seconds. The missing data was most likely due to limitations in electronically uploading and capturing that data in the system's memory after power to the unit was lost. Recorded information from the card showed that the:

- pilot departed the operator's airstrip and climbed at a rate of about 220 ft/min
- pilot flew to the field at about 500 ft AGL and returned to load the aircraft at just over 700 ft AGL
- spray runs consistently averaged 30 seconds to complete
- procedure turns took about 33 seconds to complete
- maximum height of the aircraft during the procedure turns at the southern end of the application area was between 195 and 231 ft AGL
- pilot had been spraying the field for about 5.5 minutes on the second flight before the collision occurred.

The SATLOC memory card in ATB was destroyed by fire.

Flight path reconstruction

The limited amount of recorded data prevented a precise reconstruction of each aircraft's flight path. However, using the available data, witness accounts and aircraft damage patterns, it was possible to gain an appreciation of the relative positions of each aircraft during the critical moments prior to the collision. The pilot of ATB reported taking off to the south-south-east. After becoming airborne and retracting take-off flap, he climbed at a speed of 90 KIAS and commenced a climbing, right turn toward the west-south-west. The distance along the projected flight path from the airstrip to the location of the collision measured 2.67 NM (about 5 km) on the satellite image. The elapsed time from when ATB commenced its takeoff, to the moment it collided with CJK, was estimated to be not more than 1 minute and 55 seconds.

Although the satellite tracking data for CJK was not recorded for most of that time, the data from the previous spraying runs was used to recreate its probable flight path. On that basis, the most likely sequence of events was that, at the time ATB commenced its takeoff, CJK was probably completing the procedure turn at the southern end of the application area. As ATB was commencing a climb and making a gradual right turn, CJK was completing the spray run into the north and commencing a procedure turn.

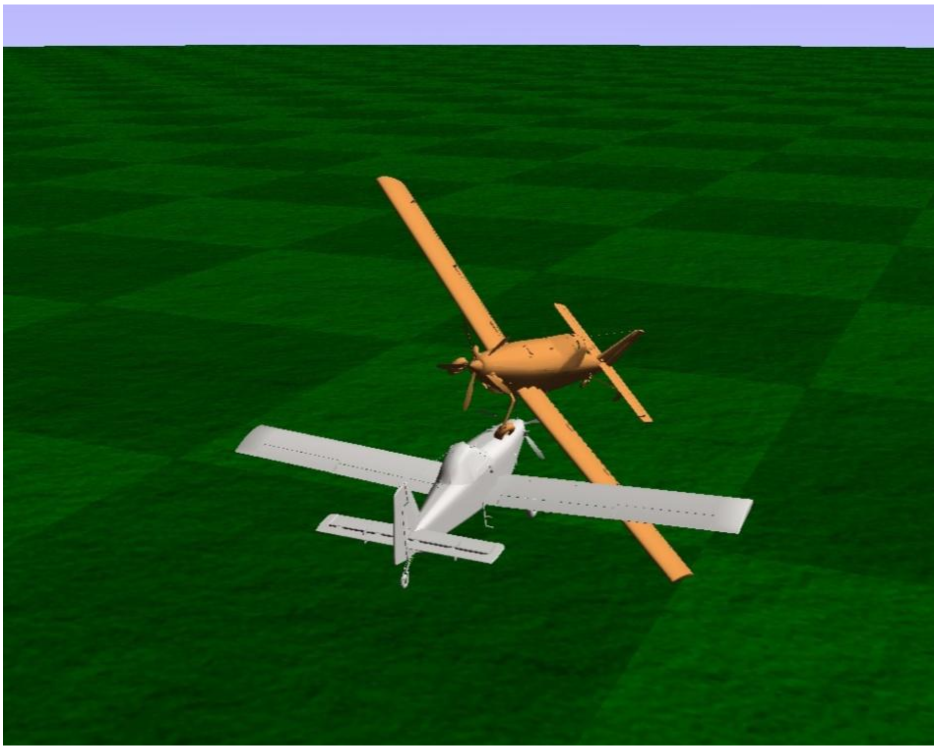
The spray run to the south was made while ATB was climbing on a west-south-westerly heading, with both aircraft on almost converging tracks. At the end of the southerly spray run, CJK would have been below the projected flight path of ATB. The pilot of CJK pulled-up from the spray run and commenced the procedure turn, initially banking to the right and away from ATB, before reversing the direction of turn. As the pilot of CJK banked left and climbed to a height of about 200 ft AGL, the bank angle increased to about 50° until about halfway through the procedure turn. At the moment of collision, CJK was on an easterly heading, almost nose-to-nose with ATB (Figures 6 and 7), although the attitude of each aircraft could not be exactly determined.

The calculated climb gradient of ATB to the point of collision at an altitude of just over 200 ft AGL was 1.4 %. That equated to a rate of climb of about 120 ft/min. The optimum climb performance for ATB at a take-off weight of 4,451.6 kg could not be determined. The manufacturer's Airplane (aeroplane) Flight Manual (AFM) stated that at 2,954 kg (6,500 lb) gross weight, climb performance under standard atmospheric conditions at sea level, '...has been demonstrated to exceed 600 FPM [ft/min] at the best rate of climb airspeed with maximum rated take-off power.'

The AFM did not provide climb performance data for gross weights other than 2,954 kg. Similarly, the climb performance was given only at the maximum rated take-off power of 680 shp, although 620 shp was recommended for use in order to increase engine life.[22] In addition, the aircraft climb configuration was not specified. Climb performance for aircraft that were configured for spraying would be less than for a basic aircraft configuration, due to increased drag from the spray equipment that was fitted to the aircraft's fuselage/wings .

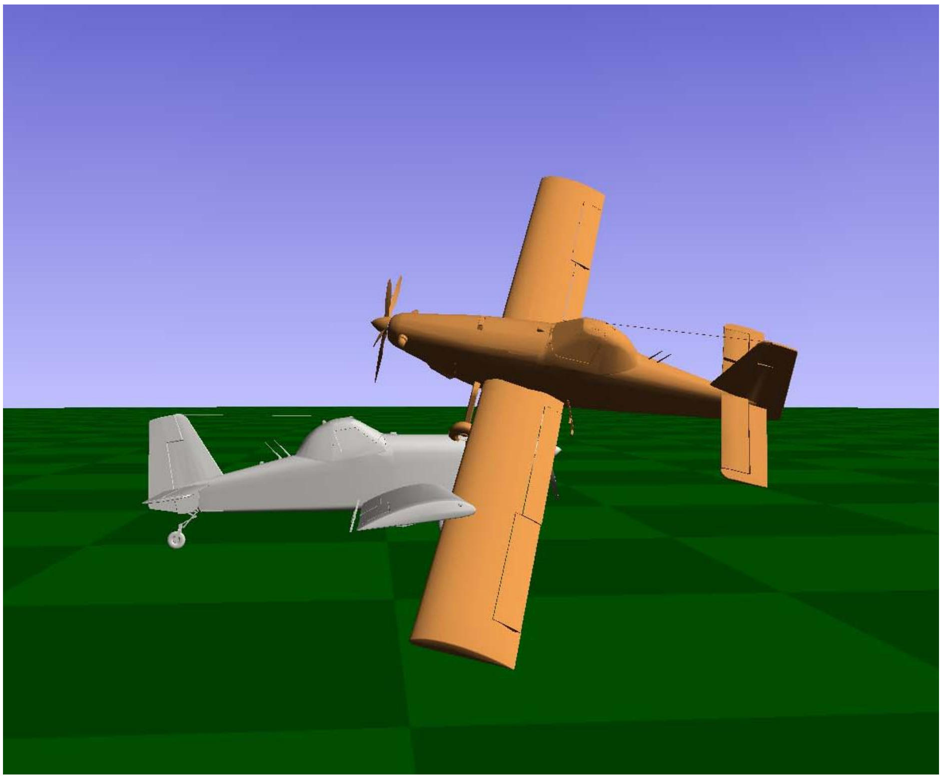
The pilot reported that it was normal practice to use climb power settings that were less than the maximum.

Figure 6: View of the derived relative position of ATB (grey) and CJK (bronze) at impact



22 Allowable total period of operation. At higher power, increased wear on engine components can require their replacement before overhaul limits are reached.

Figure 7: Another view of the derived relative positions of the two aircraft at impact



Previous occurrences

A search of the ATSB occurrence database found one previous midair collision between two aircraft while engaged in aerial application operations (BASI Occurrence No. 198000027). That accident occurred on 4 May 1980 at Cecil Plains, Queensland when two Cessna A 188 Agwagon aircraft collided during close proximity spraying operations. The report found that the pilot of one aircraft intended demonstrating a crosswind spraying technique to the pilot of the other aircraft without an adequate prior briefing.

ANALYSIS

Midair collision risk

The occurrence data showed that there is a low incidence of midair collisions during aerial agricultural operations in Australia. Similarly, the risk of midair collisions involving agricultural pilots is considerably less than a number of other risks that are normally associated with those operations, such as wire strikes, collisions with obstacles, engine failures or loss of control.

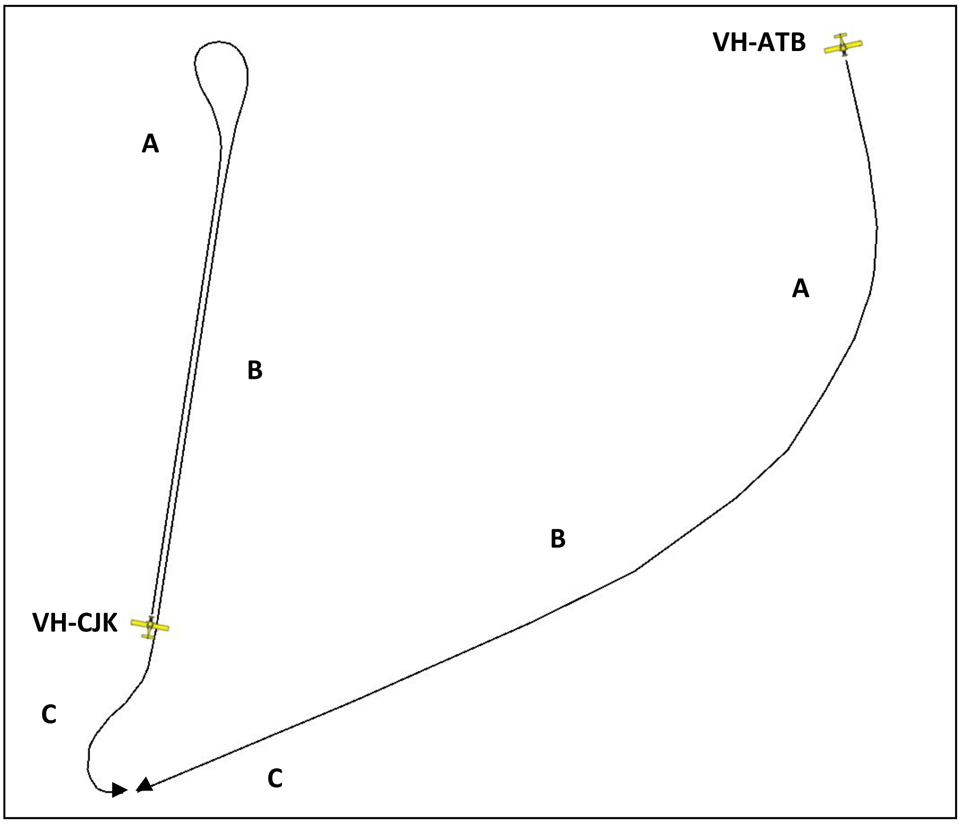
Significantly, and of importance to all pilots when flying under the visual flight rules, both pilots were operating in an unalerted see-and-avoid environment, which required either or both to see and avoid the other aircraft.

The benign weather conditions, and lack of any mechanical factor that may have contributed to the development of the accident, would suggest that the operation of either or both aircraft was a factor in the accident. This analysis will examine those operational factors.

See-and-avoid

The primary assumption of see-and-avoid as a sole means of separation is that normally a minimum of two pairs of eyes are maintaining a lookout for other aircraft. In this instance, the preoccupation of the pilot of CJK with the low-level aerial application task would have precluded a continuous visual scan by that pilot for other traffic. Although ATB would have been visible to the pilot during his southerly spray run (Figure 7 – each aircraft at about B), detection would have been very unlikely. Consequently, collision avoidance was reliant on the pilot of ATB seeing and avoiding CJK.

Figure 7: Probable flight paths of ATB and CJK



The pilot of ATB would not have had CJK in his field of view until after takeoff and making the right turn. At about that time (Figure 7- each aircraft at about A), when the pilot of ATB would have been scanning to the right to check for other traffic, CJK would probably have been well to the north of ATB. The nose-high climb attitude of ATB would not have obscured CJK during its southerly spray run until probably just before the pilot of CJK commenced the procedure turn. At about the time CJK pulled up into the procedure turn (Figure 7 – each aircraft at about C), CJK would have been obscured beneath the nose of ATB. That meant that the pilot of ATB probably had less than 1 minute in which to detect CJK. The probability of him seeing CJK during that time was minimal, considering that:

- during a climb a pilot's scan is directed to the sky above the horizon, where potential traffic conflicts are more likely to be found and not below it, where CJK was flying
- it was possible that CJK was obscured by a window pillar for some of the time
- the aircraft's converging flight paths probably meant that there was very little relative movement for the pilot's eyes to more readily perceive CJK
- the usual cockpit duties associated with the operation of the aircraft during the initial climb would have required a few moments of the pilot's attention, further reducing the time available for visual scanning for other aircraft
- the time available to complete a thorough scan that included the airspace both left and right of the aircraft's nose, as well above and below the horizon takes over 54 seconds.

The flight path of each aircraft immediately before the collision was such that the pilots, even if they had seen each other at the last moment, would not have had sufficient time to take avoiding action.

Segregation of operations

The procedures reportedly used by aerial agricultural pilots generally achieved segregation of aircraft operations. Flying at different altitudes for different phases of an aerial application flight achieved segregation except when aircraft were taking off and landing. In this instance, the proximity of CJK's application area to the airstrip resulted in ATB's departure flight path intersecting the generally avoided airspace.

The pilot of CJK was familiar with the area and would have been aware of the proximity of his application area to the airstrip and its frequent use by the pilot of ATB. Although he would have known that an agricultural aircraft taking off from that airstrip and turning at low altitude and flying through his spray area was a possibility, he probably would have expected the departing aircraft to be above his operating altitudes.

Had the pilot of ATB been aware of CJK's operations, he could have either flown clear of the application area, or climbed to pass well above CJK's maximum operating altitudes. Assuming that the airspace up to 500 ft AGL is the maximum operating level for aerial application, all pilots would benefit from climbing their aircraft to that altitude as quickly as possible, thereby minimising the risk of conflicting with nearby low-level operations.

Communications

Radio broadcasts

The pilot of ATB did not make any broadcasts on the appropriate very high frequency (VHF) aeronautical frequency. A taxiing broadcast may have provided pilots of other radio-equipped aircraft in the area with better situational awareness.

However, the carriage and use of a radio was not a requirement for operating in the Class G airspace near Wee Waa, and radio broadcasts for traffic alerting, especially in the vicinity of another operator's airstrip, would only alert pilots of radio-equipped aircraft who were monitoring the particular frequency. In this instance, the pilot of CJK could not have been alerted by any broadcast via VHF, because CJK did not have a VHF radio.

At very low altitudes, there is a greater probability of transmissions being 'masked' by terrain and not being heard by other pilots. Additionally, having pilots respond to traffic broadcasts during low-level flight could be an unacceptable distraction, especially during spraying runs. This highlights the need for pilots to be particularly vigilant in that environment.

Advice of treatment application in the vicinity of airstrips

Although pilots reported providing occasional advice about planned aerial application near another operator's airstrip, this was not formalised and was normally only provided when an application area was immediately adjacent to the other operator's airstrip. As a result of the lack of interaction between the pilots prior to this operation, neither had a full appreciation of the other's activities. In consequence, the risk of a collision was not specifically identified, and appropriate risk treatments put in place.

Mobile telephone use

Although distraction from the use of mobile phones during flight was not a factor in this occurrence, the incorporation of mobile telephones into the communications system of agricultural aircraft has the potential to create an unnecessary distraction and so increase the risk to safety. In the already high workload of the low-level environment, any additional distractions can compromise the vigilance required to effectively use the see-and-avoid principle as a sole means of separation.

Survival aspects

The pilot of CJK, although reported to have been wearing his helmet, had not secured it as the chin straps were found stowed. It could not be determined if the unsecured helmet was dislodged during the collision with ATB, or by the impact with the ground. In any event, pilot incapacitation following the collision with ATB was not considered a factor, as the aircraft would have been uncontrollable with the damage to the outboard section of the left wing and left tailplane that resulted from the midair collision.

The pilot of ATB reported that he was wearing his helmet and that it was correctly secured. Although he was unable to recall events following the midair collision with CJK, the damage to his aircraft, especially to the tail empennage, would have made it uncontrollable.

The location and condition of the pilot's seat belt and attachments in the fire-damaged cockpit of ATB contrasted with the location of the unburnt upper body restraints near the wreckage. However, the webbing of the upper body restraint straps was torn from the aircraft attachment end fittings, probably during the ground impact sequence. Their location could be explained by the pilot releasing the harness and moving away from the aircraft wreckage with the straps still over his shoulders, until they fell off when he was clear of the fire-affected area.

Conclusion

Although the possibility of another midair collision between agricultural aircraft under similar circumstances is very unlikely, it cannot be discounted. Reliance on the see-and-avoid principle has been shown to have limitations in its effectiveness for collision avoidance and can be significantly improved by traffic alerting. Radio broadcasts on the appropriate aeronautical frequency can improve pilots' situational awareness but, during low-level operations, it may not be possible to broadcast positional information due to high workload and line of sight limitations.

Existing technological solutions, such as traffic alert and collision avoidance systems, are not adaptable for use in low-level flying operations. Prior notification to the airstrip operator of planned nearby application activity would be one means of alerting pilots to potential traffic conflicts, and they could then avoid flying near the application area during the spraying activity. The confidentiality of commercial information should not restrict the dissemination of such safety information.

FINDINGS

From the evidence available, the following findings are made with respect to the midair collision that occurred on 26 February 2008 between Air Tractor aircraft, registered VH-ATB (ATB) and VH-CJK (CJK) and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The reliance on unalerted see-and-avoid did not ensure that one or both pilots saw the other aircraft in time to avoid a midair collision.

Other safety factors

- The proximity of CJK's application area to another airstrip increased the potential for a traffic conflict.
- The pilot of ATB was not aware of CJK spraying an area close to the airstrip from which he was operating, and that CJK's application area was beneath his intended flight path.
- While ATB was below 500 ft above ground level after departing the airstrip it was exposed to possible conflict with other aircraft operating in that vicinity.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of Information

The main sources of information for the investigation included the:

- pilot of VH-ATB (ATB)
- operator of VH-CJK (CJK)
- NSW Police Force
- Office of the State Coroner - NSW
- Bureau of Meteorology.

References

Advisory Circular (AC) 90-48C *Pilots' Role in Collision Avoidance* Federal Aviation Administration (FAA).

Research report 1991, *Limitations of the See-and-Avoid Principle*, Bureau of Air Safety Investigation.

Krause S S, 1995, *Avoiding Mid-Air Collisions*, McGraw-Hill Inc.

Trollip S R, Jensen R S, 1991, *Human factors for General Aviation*, Jeppesen-Sanderson Inc. pp 4-1 – 4-20.

Knowles D and Tay R, 2002, *Driver Inattention: More Risky than the Fatal Four?*, Paper presented at the Road Safety Conference.

Horrey W J and Wickens C D, 2006, *Examining the Impact of Cell Phone Conversations on Driving Using Meta-Analytic Techniques*, University of Illinois.

McKnight and McKnight 1993, *Accident Analysis and Prevention Vol 25, No. 3, pp 259 – 265, The effect of cellular phone use upon driver attention*, Pergamon Press Ltd.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003,* the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the pilot of ATB, the operator of CJK, the Aerial Agricultural Association of Australia and the Civil Aviation Safety Authority.

A submission was received from the pilot of ATB. The submission was reviewed and, where considered appropriate, the text of the report was amended accordingly.