Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation – AO-2008-010
Final

Mid-air collision
53 km NNW of Gascoyne Junction, WA
13 February 2008
VH-OUS
Piper Aircraft Corporation PA-18 Super Cub
VH-ZDP
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Mid-air collision - 53 km NNW of Gascoyne Junction, WA - 13 February 2008 - VH-OUS, Piper Aircraft Corporation PA-18 Super Cub, VH-ZDP, Robinson Helicopter Company R44 Raven

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Acknowledgements

Figure 1: Airservices Australia
Figure 3: USAF Pilot Training Class 55-I Association web site, http://pilotclass55india.org/
Figure 10 inset: Robinson Helicopter Company R44 II Pilot's Operating Handbook
Appendix B: Russell and Mary Dann for provision of Piper Super Cub, VH-LFA

Abstract

On 13 February 2008, a Piper Aircraft Corporation PA-18 Super Cub aircraft and a Robinson Helicopter Company R44 Raven helicopter were engaged in feral goat culling operations in the Kennedy Range National Park, WA.

The two aircraft collided in mid-air as the pilot of the helicopter executed a climbing left turn that brought the two aircraft into close proximity. The pilot and shooter occupants of the R44 were aware that the Super Cub was approaching them at the same height, and the helicopter pilot was aware of the position of the aeroplane during the helicopter's climbing turn, but it appeared probable that the pilot and spotter occupants of the Super Cub did not see the helicopter.

The helicopter's main rotor blades struck the Super Cub's right wing, severing the lift struts. The right wing detached in flight, and the Super Cub fell to the ground. The pilot and spotter were fatally injured. The helicopter was able to land safely.

The investigation determined that the occupants of the Super Cub were probably unaware of the proximity of the R44, and that the R44 pilot did not recognise the collision hazard until there was insufficient time to prevent contact with the Super Cub.

The investigation also identified that there were no formalised operating procedures detailing the conduct of culling operations involving multiple aircraft that may have assisted in the maintenance of aircraft separation.

In response to this accident, a number of safety actions were undertaken by the R44 and Super Cub operators. In addition, extensive safety action was carried out by the WA Government departments that were involved in the operation. That included in the areas of risk management, the review and amendment of guidelines and procedures affecting multiple aircraft operations, the adoption of Safety Management Systems, and the provision of training for departmental personnel.

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.

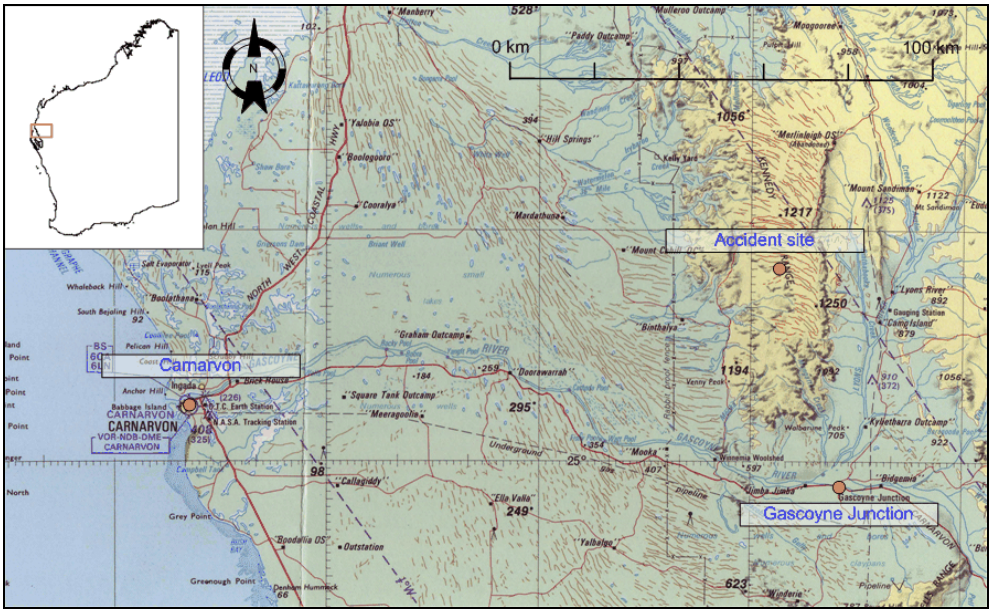
FACTUAL INFORMATION

History of the flight

On 13 February 2008, a Piper Aircraft Corporation PA-18 Super Cub (Super Cub) aircraft, registered VH-OUS, and a Robinson Helicopter Company R44 Raven (R44) helicopter, registered VH-ZDP, were engaged in feral goat culling operations in the Kennedy Range National Park, WA. The two aircraft were operating under the visual flight rules (VFR) from Gascoyne Junction airstrip (Figure 1) and had completed two similar culling flights earlier in the day before the accident flight.

At about 1805 Western Daylight-saving Time[1], the two aircraft departed from Gascoyne Junction. On board the R44 were the pilot and a shooter. On board the Super Cub were the pilot and a spotter. The primary role of the Super Cub's occupants was to assist the R44 pilot to locate feral goats for culling.

Figure 1: Area map



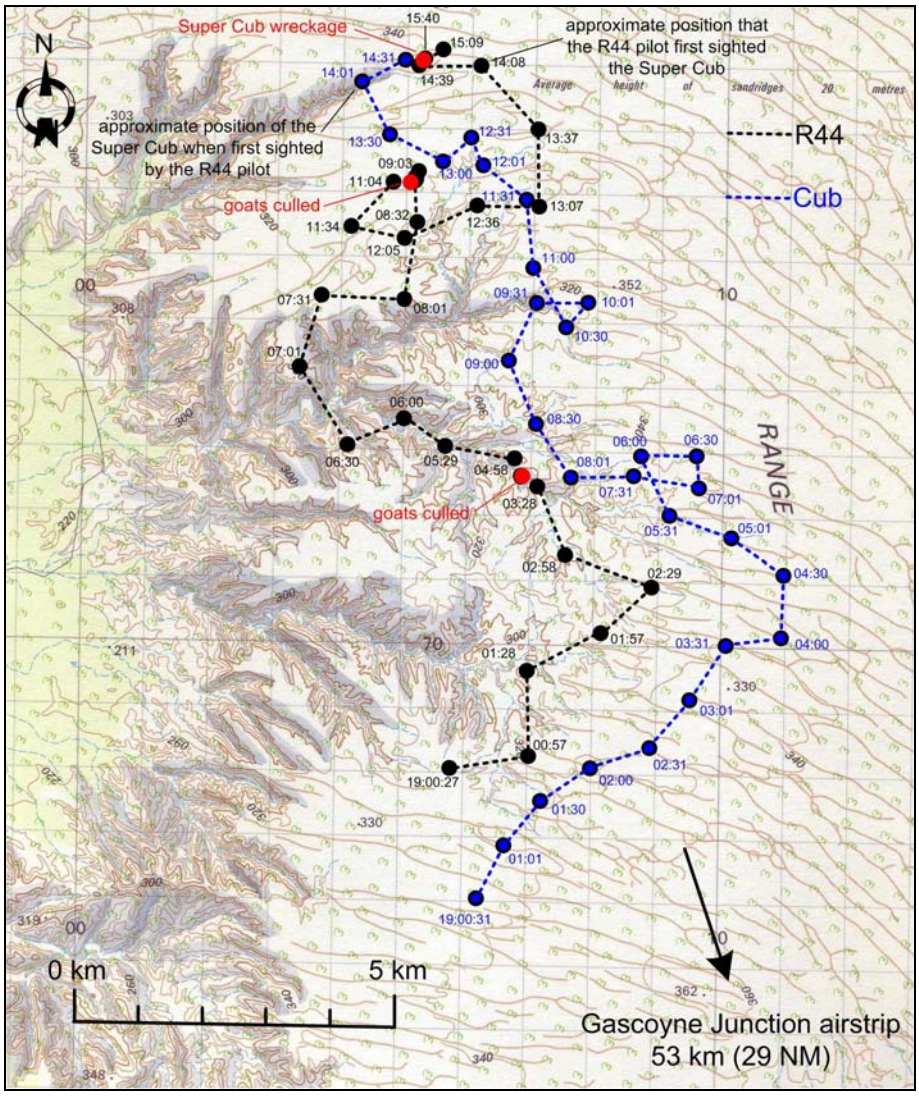
The operation proceeded without incident until about 1914, when the occupants of the R44 observed the Super Cub about 2 km away and flying towards them. The Super Cub was slightly offset to their left and at the same height, estimated by the R44 pilot to be about 300 ft above ground level (AGL) (Figure 2). The pilot of the R44 reported that, as the two aircraft approached each other, the Super Cub banked away from the R44 briefly, before resuming wings level flight on an easterly heading.

The pilot of the R44 stated that, at about the time the Super Cub was observed to bank, he commenced a climbing left turn to take up a reciprocal heading (easterly) in order to continue the search for goats, and to keep the aeroplane in sight. At

1 The 24-hour clock is used in this report to describe the local time of day, Western Daylight-saving Time, as particular events occurred. Western Daylight-saving Time is Coordinated Universal Time (UTC) + 9 hours.

about the time the R44 passed through south, the Super Cub passed beneath it. The R44 pilot's assessment was that the Super Cub's occupants would have been unable to see the helicopter at that time. The R44 pilot continued the left turn to keep the Super Cub in sight and, while turning through east, observed the right wing of the Super Cub move left underneath the R44 until only the right wingtip was visible. He reported that the right wing then appeared to rise quickly and, in response, he increased the left bank and raised the collective lever[2] in an attempt to remain clear.

Figure 2: GPS track data for both aircraft[3]



The R44 pilot stated that, despite the avoidance manoeuvre, the Super Cub appeared to significantly out-climb the helicopter and he assessed that a collision was imminent. He recalled that he intended to level the helicopter in order to absorb

2 Raising the collective lever increases the main rotor thrust (effectively lift) produced by the main rotor blades.

3 Both aircrafts' onboard GPS units recorded their respective aircraft's position at 30 second intervals. The lines between those recorded points approximate the aircrafts' movement and do not accurately reflect any turns by the aircraft – for example, the turn described by the R44 pilot prior to the collision.

the impact on the skids, but had insufficient time to apply any control input before the two aircraft collided.

The R44 pilot indicated that he was unconcerned by the proximity of the Super Cub until its wing began to rise.

The shooter reported that, during the conduct of the climbing left turn, an ammunition container located at his feet shifted slightly, and that he leaned forward to reposition it. He recalled that, as he resumed his normal seating posture, he felt the helicopter climb followed almost instantaneously by the collision. The shooter recalled last seeing the Super Cub pass to his left at a lower altitude before his attention was diverted inside the helicopter by the movement of the ammunition container.

The R44 pilot stated that the last radio communication between the two aircraft occurred about the time they first approached within about 2 km of each other. The shooter did not recall hearing any radio transmissions from the time that he initially sighted the Super Cub.

The two aircraft collided at about 400 ft AGL. The right wing of the Super Cub detached from the fuselage in-flight, and the aircraft impacted the ground inverted in a steep, nose-down attitude. The pilot of the R44 retained sufficient control of the helicopter to conduct an initial approach to a low hover. On visually identifying the location of the Super Cub, the pilot of the R44 hover-taxied to the vicinity of the wreckage before landing to render assistance to the occupants.

The R44 pilot and shooter established that both occupants of the Super Cub had been fatally injured. The R44 pilot and shooter were uninjured.

The helicopter's main rotor blades and the Super Cub were seriously damaged.

Personnel information

Super Cub pilot

The Super Cub pilot held a Commercial Pilot (Aeroplane) Licence that was issued on 20 April 2006. He held the required aircraft class and design feature endorsements to operate the Super Cub.

At the time of the accident, he had accrued 1,793.7 hours flight time, of which 266.2 hours were in Super Cub aircraft. Nearly all of his Super Cub hours were flown in the accident aircraft while conducting spotting activities, including the conduct of previous feral goat culling operations with the same R44 pilot in 2007.

The Super Cub pilot had completed low-level flying training that, in conjunction with the required procedures and approvals held by the aeroplane operator[4], permitted spotting operations to be conducted below 500 ft AGL.

The Super Cub pilot was conducting the spotting activity in accordance with an exemption from the flight and duty time limitations set out in Part 48 of the Civil

4 Civil Aviation Regulation (CAR) 2 defined an operator as '...a person, organisation, or enterprise engaged in, or offering to engage in, an aircraft operation'.

Aviation Orders (CAO). He was operating within the requirements of that exemption at the time of the accident.

The Super Cub pilot held a valid Class 1 medical certificate without restriction.

R44 pilot

The R44 pilot had flown for the helicopter operator since 1997, including in the conduct of aerial work and charter operations. He held a Commercial Pilot (Helicopter) Licence that was issued in 1994, and was endorsed on the R44 in 1997. He also held an Agricultural Pilot (Helicopter) Rating Grade 2, and an approval to undertake aerial stock mustering operations[5].

At the time of the accident, the R44 pilot's logbook indicated that he had accrued 9,607.4 hours flight time, with more than 4,000 hours operating R44 helicopters. He estimated that about one third of his flying experience was gained conducting operations in the vicinity of other aircraft, principally other helicopters.

The R44 pilot's most recent flight review was conducted on 3 April 2006, and he held a valid Class 1 medical certificate without restriction.

The R44 pilot was conducting the spotting and culling activity in accordance with an exemption from the flight and duty time limitations set out in Part 48 of the CAOs. He was operating within the requirements of that exemption at the time of the accident.

Aircraft information

Super Cub

Aircraft specifications

The Super Cub, serial number 18-7881, was manufactured in the US in 1963. It was registered in the operator's name in June 2005.

The Super Cub was a high-wing, tailwheel aeroplane that combined a metal structure with resin-impregnated fabric skin (Figure 3). The aircraft provided for two occupants seated in tandem[6]. In this case, the spotter was seated behind the pilot, and the rear control stick was removed, leaving only the rudder pedals and engine throttle control at that seating position.

The aeroplane had a maintenance release that was issued for operations in the aerial work category, and was valid until 19 September 2008 or 3,110.7 hours in service.

At the time of the accident, the Super Cub had been operated for a total of 3,060.6 hours.

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5 CAO 29.10 defined aerial stock mustering as 'the use of aircraft to locate, direct and concentrate livestock while the aircraft is flying below 500 ft AGL and for related training operations.'

6 Tandem seating: Capability for one pilot (or passenger) to be seated in front or behind the pilot of the aircraft.

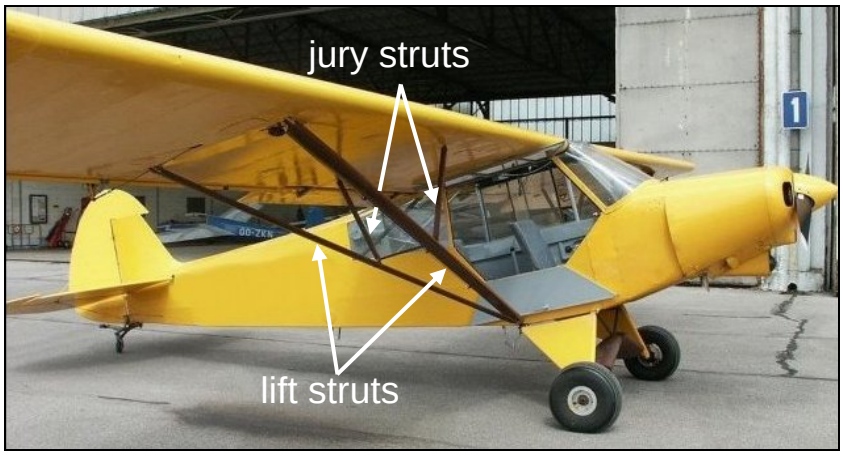
Recent maintenance history

The Super Cub last underwent scheduled maintenance on 18 September 2007 at 3,010.7 hours in service. That maintenance included the overhaul of the alternator and one of the engine cylinder assemblies, and the replacement of the remaining three engine cylinders.

The maintenance release that was valid at the time of the accident included a requirement to change the engine oil at 3,035.7 and 3,060.7 hours in service. Neither of those oil changes were certified on the maintenance release as having been carried out. However, a second spotter that was involved in the culling operation at Kennedy Range recalled that the Super Cub pilot[7] changed the aircraft's engine oil some time after the aircraft's arrival at Gascoyne Junction on 10 February 2008.

During the first flight on the day of the accident, radio communication difficulties were encountered between the pilots, and also between the Super Cub pilot and the Gascoyne Junction base. Both aircraft landed within the Kennedy Range National Park so that the fault could be identified. However, the source of the problem was not identified and the flight was continued using modified procedures. On return to Gascoyne Junction, it was found that the battery had discharged because of a loose alternator field wire. That problem was rectified and no further radio communication difficulties were reported.

Figure 3: Example of a Piper PA-18 Super Cub



R44

Aircraft specifications

The R44, serial number 1246, was manufactured in the US in 2002. At the time of the accident, the helicopter's registration was in the process of being transferred to the R44 pilot.

The R44 is a four-seat, single main rotor helicopter that is powered by a six-cylinder piston engine and is equipped with skid-type landing gear.

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7 Changing or replenishing of engine oil was one of a number of maintenance items that could be performed by a pilot in accordance with CAR subregulation 42ZC (4).

The helicopter's main rotor comprises two all-metal rotor blades with stainless steel leading edges and blade skins.

The helicopter had a maintenance release that was issued in the aerial work/charter operational categories and was valid until 1 February 2009 or 2,092.2 hours in service.

At the time of the accident, the helicopter had been operated for a total of 2,037.0 hours.

Recent maintenance history

The R44 last underwent maintenance on the 6 February 2008. That unscheduled maintenance was as a result of in-flight engine rough running and misfiring that was experienced by the R44 pilot. Following that maintenance, which consisted of the replacement of five engine cylinders, the helicopter was reported to operate normally.

Weight and balance

Weight and balance calculations undertaken during the investigation indicated that the R44 was operating within the allowable gross weight and centre of gravity limits at the time of the accident.

The investigation was unable to determine the quantity of fuel on board the Super Cub at the time of the accident due to the incomplete fuel records for that day. However, the available fuel records from the preceding flights indicated that the Super Cub was refuelled to full tanks on all but one of those flights.

Weight and balance calculations suggested that the Super Cub was operating within the allowable gross weight and centre of gravity limits whatever the fuel quantity on board for the accident flight.

Meteorological information

Weather conditions

The area forecast[8] for the flight predicted isolated thunderstorms and showers, and associated cloud with a base of 2,000 ft above mean sea level (AMSL).

There were no direct observations of the weather conditions in the vicinity of the accident site. At 1500, the recorded conditions at Gascoyne Junction, 53 km to the south-south-east, were 40.2° C and 16% relative humidity. Although the temperature at the time of the accident was not recorded, the R44 pilot's recollection of the temperature at that time was consistent with the 1500 Gascoyne Junction observation.

A Bureau of Meteorology (BoM) after-flight analysis stated that the observed weather conditions were consistent with those forecast. Specifically, radar imagery

8 For the purposes of providing aviation weather forecasts to pilots, Australia is sub-divided into a number of forecast areas. The occurrence flight was contained in Area 65.

of rainfall echoes and detected lightning strikes in the vicinity of Binthalya, about 27 km south-west of the accident site, were consistent with the forecast thunderstorms and showers.

The BoM report stated that the likely wind conditions at the time of the accident were light and variable. However, the presence of thunderstorms may have produced significant variations in local wind speed and direction.

Natural light conditions

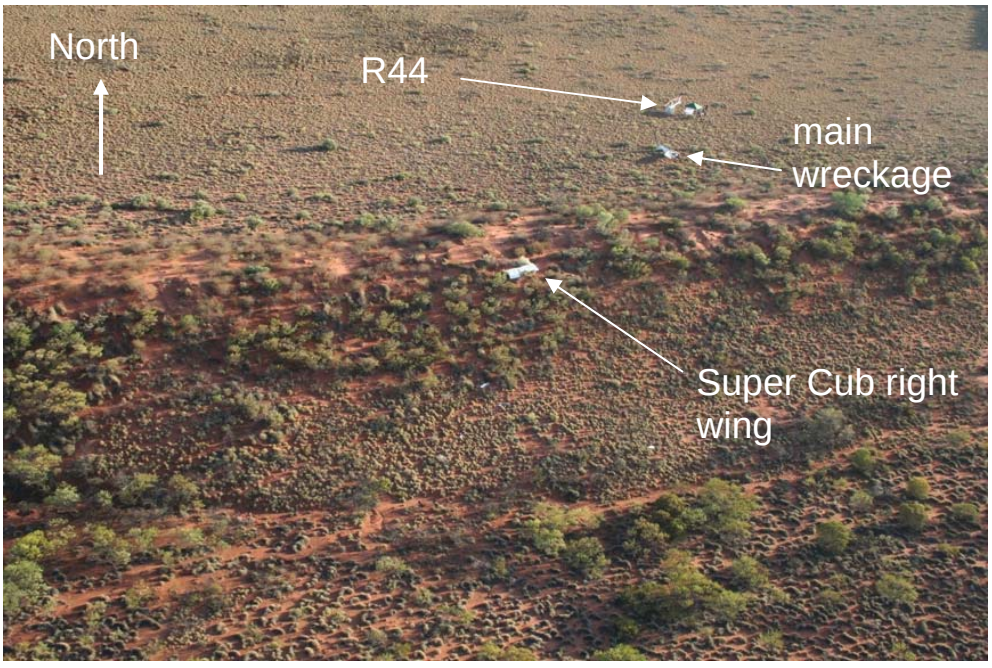
The position of the sun at the reported time of the accident was determined from the Geoscience Australia website. The sun's azimuth[9] at that time was 259°32'59" and its altitude[10] 9°53'12".

The R44 pilot reported that the position of the sun did not affect his ability to identify the Super Cub flying towards him. The wreckage trail of the aeroplane, and reports from the occupants of the R44, were consistent with the collision occurring while the aircraft were tracking to the north-east, placing the sun directly behind both aircraft.

Wreckage and impact information

The accident occurred over relatively flat terrain characterised by regular sand ridges 20 m high and orientated approximately east to west (Figure 4). The elevation of the accident site was about 1,150 ft.

Figure 4: Accident site

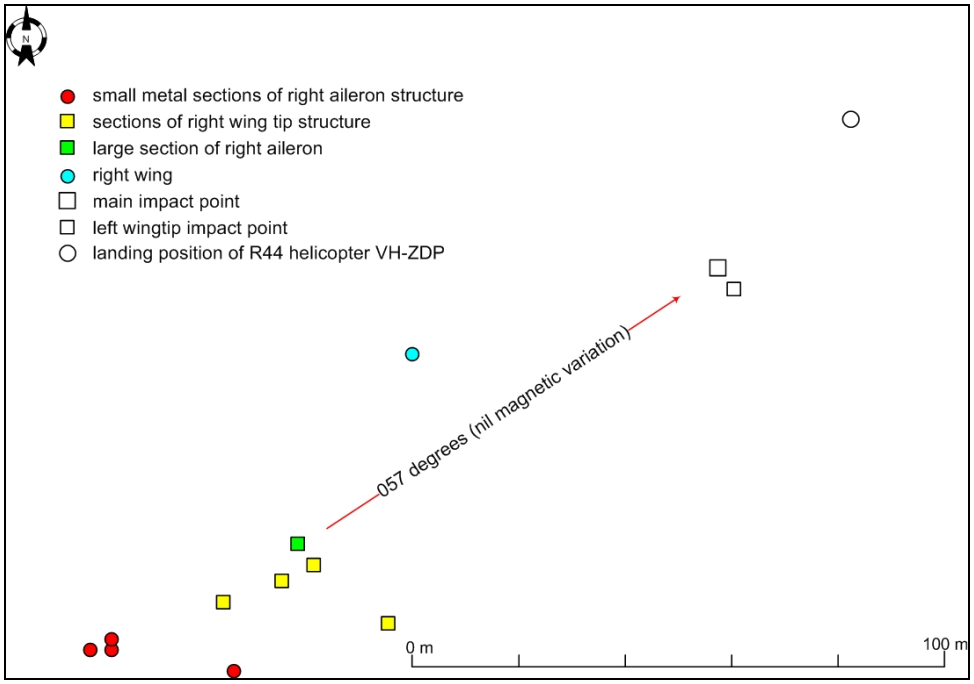


9 The clockwise horizontal angle from the sun to true north, measured in degrees, minutes, and seconds.

10 The vertical angle to the sun from an ideal horizon, measured in degrees, minutes, and seconds.

The wreckage trail of the Super Cub was orientated about 057° and extended about 130 m across a sand ridge. The wreckage trail comprised the right wing and associated aileron and wing tip structure, and the main wreckage (Figure 5).

Figure 5: Super Cub wreckage trail

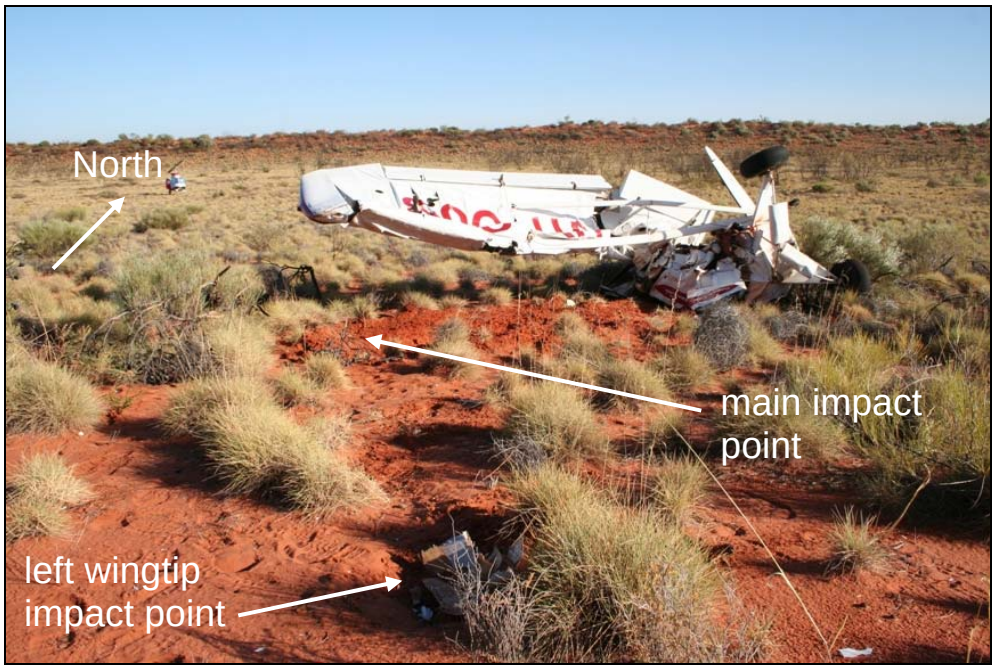


Wreckage examination

Super Cub

The aircraft impacted the ground inverted in a steep, nose-down attitude. Following the initial impact, it rotated to the right before coming to rest inverted, a short distance from the initial impact point (Figure 6). Upon landing after the collision, the R44 occupants observed fuel was leaking from the left wing fuel tank of the Super Cub.

Figure 6: Super Cub wreckage



The contact damage to the Super Cub was limited to the right wing and associated support struts, with the R44 main rotor blades severing both wing lift struts and impacting the wing rear spar, aileron and wing tip (Figures 7 and 8). Following the severing of the lift struts, the wing fractured at the inboard attachment fittings and detached from the fuselage in flight.

Figure 7: Wing and lift strut damage

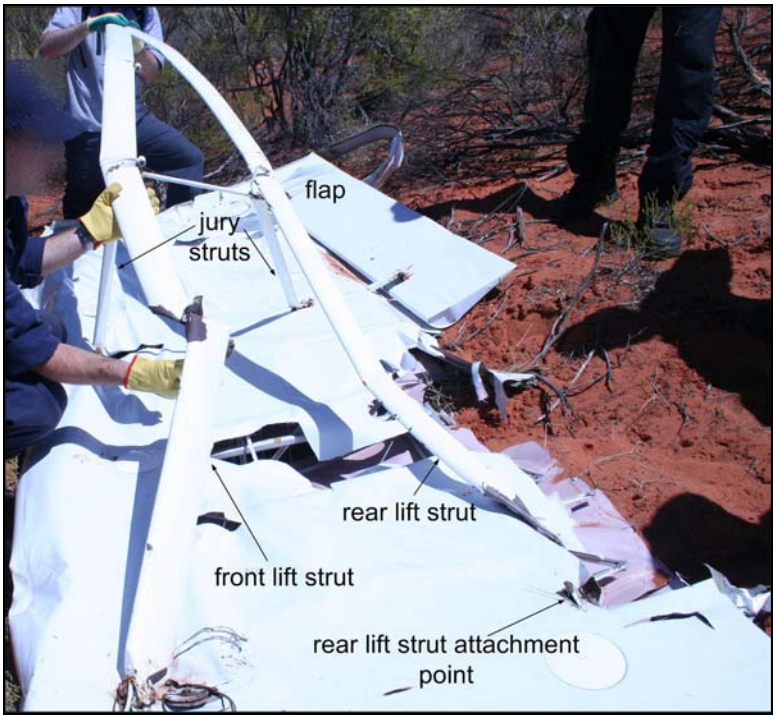
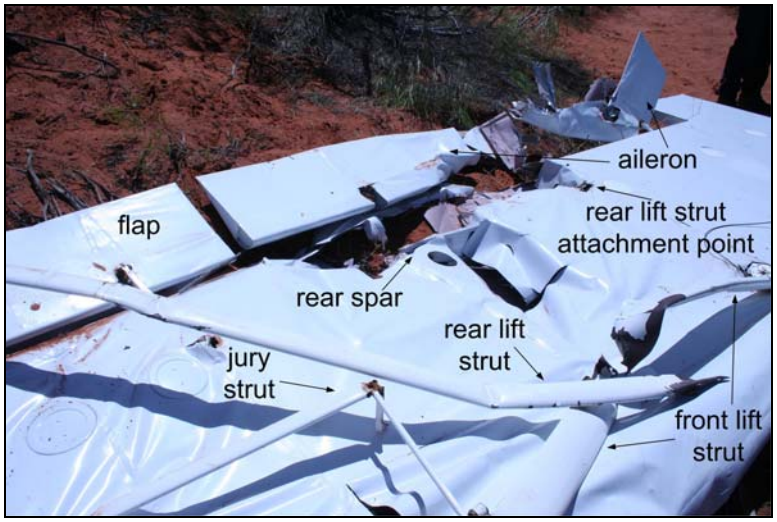


Figure 8: Wing and aileron damage



All components of the Super Cub were accounted for at the accident site and the continuity of all of the aircraft's flight controls was confirmed.

The position of the fuel selector at the time of the accident could not be determined.

The Super Cub's engine, propeller, and engine tachometer were removed from the accident site for disassembly and technical examination.

R44

There was substantial damage to one of the main rotor blades consistent with the in-flight contact with the Super Cub's right wing (Figure 9). A section of the blade's skin and honeycomb structure was forced upwards between the leading

edge spar and the trim tab, with part of the Super Cub's wing fabric retained within the blade. In addition, the blade tip had a section of the skin and honeycomb missing at the trailing edge. Both main rotor blades showed paint transfer along most of their length, and there were creases on the lower surface of the blades' skin.

There was also evidence of paint transfer and impact damage on the lower left area of the R44's chin bubble (Figure 10), consistent with contact between the helicopter and the Super Cub's right wingtip. The R44 pilot reported that that contact resulted in buckling of the floor pan.

The investigation was unable to determine at what point in the collision sequence the contact occurred between the R44 chin bubble and the aeroplane.

Figure 9: Main rotor blade damage

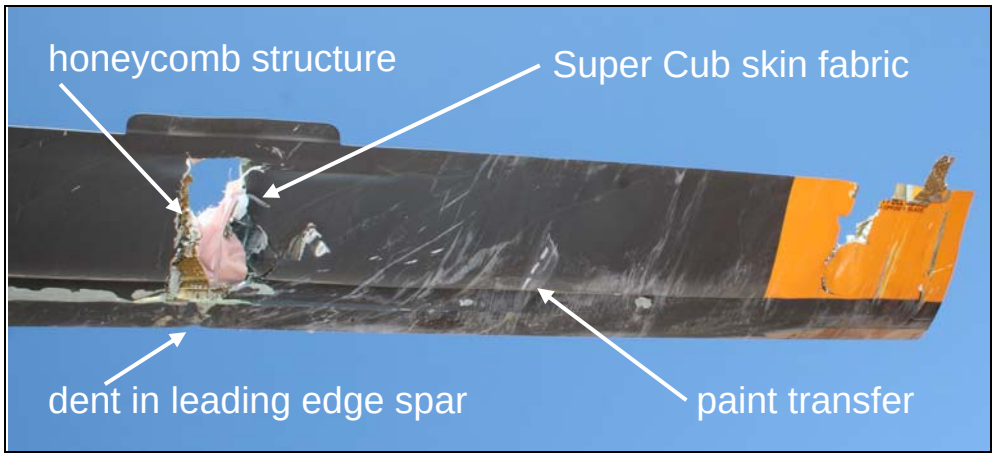
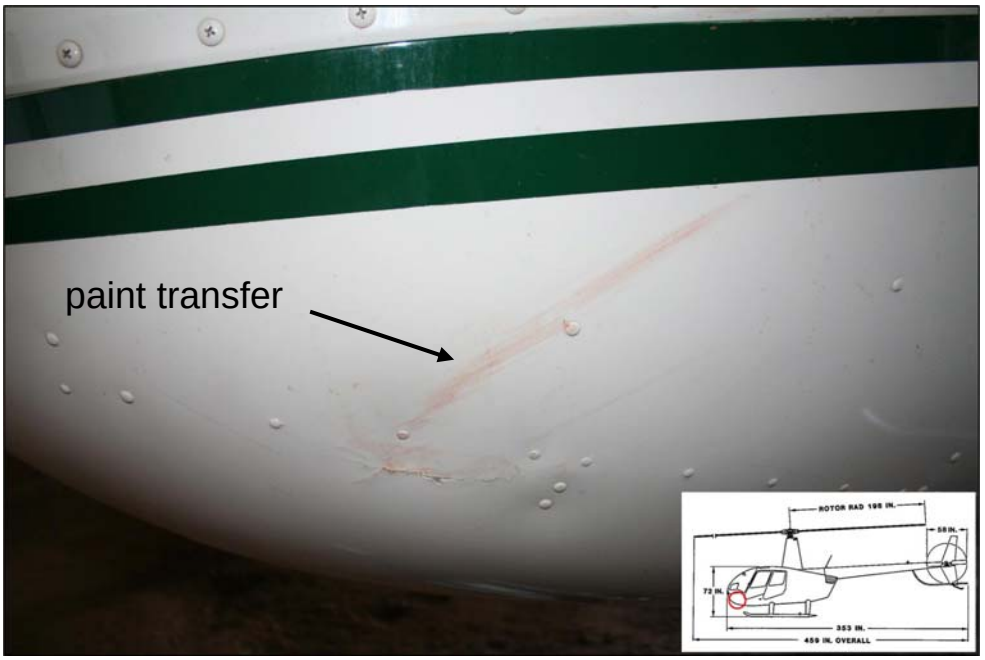


Figure 10: Chin bubble paint transfer



An assessment of the relative position of the two aircraft at impact was undertaken using the contact marks on both the Super Cub wing structure, including the wing lift struts, and the substantially damaged R44 main rotor blade. The results of that analysis, which did not take into account the contact marks on the R44 chin bubble, are shown at Appendix A.

A number of components from the Super Cub were recovered for technical examination.

Examination of components recovered from the Super Cub

Engine

The engine was examined at an approved engineering facility under the supervision of the Australian Transport Safety Bureau (ATSB).

The disassembly of the engine cylinders during the engine examination identified one broken piston compression ring in one cylinder. That broken ring was retained within its associated piston groove. There was no scoring or other associated damage to the cylinder wall or piston grooves that may have prevented normal engine operation. In addition, the examination found evidence within the venturi of the carburettor of red soil deposits, which extended into the combustion chamber of one of the engine cylinders. The engine induction system was found to be intact and undamaged.

The engine disassembly and inspection did not reveal any defect or anomaly that would have prevented the engine from operating normally. The power output of the engine at the time of collision with terrain could not be determined.

Propeller

The propeller was transported to the ATSB's facilities in Canberra for technical examination.

The examination of the propeller, propeller flange, and associated engine crankshaft section indicated that the Super Cub impacted the sandy terrain in a near vertical attitude, with the propeller rotating under little or no engine power.[11]

Engine tachometer

An examination of the engine tachometer indicated that, at the time the aeroplane collided with terrain, the engine and propeller were rotating at about 1,450 RPM (Figure 11). That rotational speed was less than would be expected for cruise flight.

Figure 11: Engine tachometer

Medical and pathological information

A review of the Super Cub pilot's aviation-related medical records and of the results of his post-mortem examination found no evidence of any pre-existing medical disease, sudden illness, or incapacitation that may have affected his ability to control the aeroplane.

Toxicological analysis revealed that the Super Cub pilot had a mildly raised blood alcohol level although, given a number of factors that can influence the post-mortem production of alcohol[12], the validity of that result could not be assured.

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11 The propeller of an inoperative engine could continue rotating due to the airflow that was produced by the forward airspeed of the aeroplane. That effect was known as 'windmilling'.

12 See the research paper Dr Shelley Robertson (2005). *Interpretation of Measured Alcohol Levels in Fatal Aviation Accident Victims*: http://www.atsb.gov.au/publications/2005/Measured_alcohol_lev.aspx

There was no evidence that the pilot had not complied with the regulatory requirements affecting the consumption of alcohol, as detailed in CAR 256.

Organisational and management information

Collision avoidance

The regulatory requirements affecting the operation of aircraft in close proximity to one another, and the prevention of collision, are outlined in Part 12, Division 1 of the CARs.

In regard to the prevention of collision, CAR 161(2) stated:

> ...nothing in the rules in this Division shall relieve the pilot in command of an aircraft from the responsibility of taking such actions as will best avert collision.

In addition, CAR 162(3) stated that:

> An aircraft that is being overtaken has the right-of-way and the overtaking aircraft[13], whether climbing, descending, or in horizontal flight, shall keep out of the way of the other aircraft by altering its heading to the right, and no subsequent change in the relative positions of the two aircraft shall absolve the overtaking aircraft from this obligation until it is entirely past and clear.

Further, CAR (163A) specified the responsibility of flight crew to see-and-avoid other aircraft as follows: [14]

> When weather conditions permit, the flight crew of an aircraft must, regardless of whether an operation is conducted under the Instrument Flight Rules or the Visual Flight Rules, maintain vigilance so as to see, and avoid, other aircraft.

In respect of the operation of an aircraft in close proximity to another aircraft, CAR 163(1) stated:

> The pilot in command of an aircraft must not fly the aircraft so close to another aircraft as to create a collision hazard.

Multiple aircraft aerial work operations

There were no regulations specifically applicable to the operation of two or more aircraft conducting aerial cull operations. However, Civil Aviation Safety Regulation (CASR) 137.010 applied to the conduct of aerial application

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13 CAR 160 defines an overtaking aircraft as: '...an aircraft that approaches another aircraft from the rear on a line forming an angle of less than 70° with the plane of symmetry of the latter, that is to say, an aircraft that is in such a position with reference to another aircraft that at night it would be unable to see either of the forward navigation lights of the other aircraft.'

14 An in-depth examination of the see-and-avoid principle was carried out in the ATSB research report, *Limitations of the See-and-Avoid Principle* (available at www.atsb.gov.au).

operations[15] (for example crop-dusting) involving two or more aeroplanes. In addition, a draft regulation (now superseded) was identified during the investigation that applied to aerial stock mustering involving two or more helicopters.

Multiple aircraft aerial application operations

In regard to aerial application operations, CASR 137.165(3) required that:

> The pilot in command of an aeroplane must not engage in close proximity operation[16] unless the operation is coordinated by:
>
> (a) if the operation is to be conducted by 1 operator – the operator's head of flight operations, or another person nominated by the operator; or
>
> (b) otherwise – a suitably qualified pilot agreed to by all pilots involved in the operation.

The coordinator's responsibilities were outlined in CASR 137.165(4) and included that:

> The coordinator must give, to all pilots involved in the operation, instructions about the following:
>
> (a) transit between the landing area and the work area
>
> (b) radio communications, including loss-of-communication procedures
>
> (c) refuelling arrangement
>
> (d) the conduct of the operation.

In addition, CASR 137.165(5) required that:

> During the operation each pilot must:
>
> (a) maintain safe lateral separation from the other aeroplanes by visual and radio contact; and
>
> (b) comply with the instructions of the person coordinating the operation.

Multiple helicopter mustering operations

Draft CASR 133.1425(2), now superseded, detailed the conduct of close proximity aerial stock mustering[17] operations involving two or more helicopters, provided additional relevant material. In particular, paragraph two of that draft regulation stated:

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15 An aerial application operation was defined as a flight carried out by an aeroplane to apply fertiliser, trace elements, seeds, baits, water, pesticides or other material.

16 CASR 137.165(1) defined close proximity operation as: '...flying so close to each other during an application operation as to create a collision hazard if special measures are not taken.'

17 Close proximity aerial stock mustering was defined as '...operations involving the use of 2 or more rotorcraft operating in closer proximity to each other than 100 metres horizontally and 300 feet vertically.'

The operator must include in the operator's operations manual, procedures for the conduct of close proximity aerial stock mustering, including procedures relating to the following:

(a) briefings to pilots involved in the operations

(b) communications between the rotorcraft involved, and the loss of such communications

(c) safe lateral separation of the rotorcraft involved.

Aerial culling program

Background

The aerial culling program was initiated by the WA Department of Environment and Conservation (DEC) in 2006/2007 to reduce the environmental impact of feral goats in the Kalbarri, Cape Range, François Peron, and Kennedy Range National Parks.

The 2007/2008 program was intended to continue the previous year's program. At the time of the accident, all of the intended culling operations in the Cape Range National Park, and about half those planned in the Kennedy Range National Park, had been completed.

The DEC contracted the Department of Agriculture and Food, WA (DAFWA) to assist with the program due to a lack of qualified shooters in the DEC, and the limited experience of DEC personnel in the conduct of aerial culling operations. It was intended that culling programs would be conducted independently by the DEC once their personnel gained the necessary qualifications and experience.

In addition to the provision of qualified shooters, the DAFWA sourced the helicopter and its pilot through an existing contract with the helicopter operator. The DEC and DAFWA both had input into the engagement of the Super Cub and its pilot. There was no written contract between either party and the Super Cub operator. Broadly, the DEC provided the spotters and ground radio operators, and was also responsible for the logistics in support of the program; such as the provision of ammunition, food, and accommodation.

The R44 pilot had participated annually in the culling operation since its inception in 2006. The Super Cub pilot had participated in the program, with the R44 pilot, since 2007. The shooter on board the R44 at the time of the collision had been involved in the program since 2007. A second shooter involved in the program had participated in the culling operation annually since 2006.

Operating procedures

Department of Environment and Conservation

The DEC produced a 'shooting plan' that provided detail on the conduct of the culling operation within each national park. That plan was used as the basis for an introductory briefing for the program, which was conducted by DEC management, and attended by all of the involved parties, before commencing culling operations in the Cape and Kennedy Range National Parks. The DEC manager who delivered

the program briefing recalled emphasising the need for vertical separation between the two aircraft during shooting operations.

The Kennedy Range shooting plan detailed the following aspects of the operation:

- the justification for the aerial culling program
- weapon safety considerations, including procedures for public notification of the intended shoot, and methods to restrict public access
- the communications procedures to be used between the aircraft and ground stations, including the use of both ultra high frequency (UHF) radios and of satellite telephones
- the required safety equipment to be available to involved personnel
- the aircraft operating procedures, specifically the:
  - details of the landing zones to be used
  - refuelling procedures
  - requirement for the Super Cub pilot to transmit radio calls to the Gascoyne Junction base every 30 minutes to confirm the normal operation of both aircraft and the response by ground personnel in the event that a scheduled call was not received
  - need for a pre-flight briefing involving all aircraft occupants prior to each flight. That briefing was to identify the intended area of operation and potential risks affecting each flight. The R44 pilot and shooters confirmed that those briefings were conducted prior to the culling flights at both Cape and Kennedy Ranges.

Department of Agriculture and Food, WA

The DAFWA produced two documents containing procedural information that was relevant to the conduct of aerial culling. The first of those documents, *Guidelines for Safe Aerial Work in Remote Areas*, outlined the types of aerial work undertaken by DAFWA and the contractual basis for those operations. The document detailed the selection criteria for prospective operators, and included a number of minimum specified requirements relating to the operator, the pilot, and to the aircraft. The remainder of the document related to training and equipment requirements affecting the participation of DAFWA employees in the operation.

The second of the DAFWA documents, *Communication for Aircraft Working in Remote Areas*, recognised that aircraft may operate in close proximity to each other when engaged in aerial culling, and also the risk of in-flight collision - albeit with aircraft other than those involved with the culling operation. In order to mitigate those hazards, the document specified the need for scheduled radio calls to a ground base, similar to those in the DEC shooting plans, as well as the requirement for general radio broadcasts to alert other aircraft that might be operating in the area.

The R44 pilot stated that he was unaware of either of those DAFWA guidelines.

R44 operator

The R44 operator held the required CASA approvals to conduct aerial spotting and feral and diseased animal control at heights lower than 500 ft AGL.

The company Operations Manual detailed procedures for the conduct of both aerial spotting and stock and feral animal control. The procedures did not include the conduct of those activities with other aircraft.

The chief pilot reported that specific operating procedures were not discussed with the R44 pilot due to his extensive flying experience and past involvement in previous culling programs with the same personnel. The chief pilot believed that combined aeroplane and helicopter operations were discussed previously by the operational personnel that were involved in the conduct of the cull. Similarly, the chief pilot did not discuss any specific operating procedures for the cull with the other involved parties, due to their past experience operating together and the expectation that a discussion of specific procedures would take place between the operational personnel prior to the commencement of the culling program.

The chief pilot believed that aircraft separation would be achieved by a combination of radio communication between the two aircraft, and by the application of different aircraft operating heights AGL, with the Super Cub operating above the R44.

Super Cub operator

The Super Cub operator also held the necessary CASA approvals for the conduct of aerial spotting at heights lower than 500 ft AGL.

The company Operations Manual detailed procedures for the conduct of aerial spotting. However, those procedures did not cover the conduct of that activity with other aircraft.

As in the case of the R44 pilot's Chief Pilot, the Chief Pilot of the Super Cub operator stated that specific operating procedures were not discussed with the Super Cub pilot due to his flying experience, past involvement in previous culling programs, and the expectation that the involved helicopter and aeroplane pilots would determine the most effective procedure for the conduct of the cull.

The chief pilot believed that aircraft separation would primarily be achieved by the application of different operating heights, with the Super Cub operating above the R44.

Operating height

The R44 pilot recalled that a discussion specifying the operating heights of both aircraft took place prior to the 2008 aerial culling program as part of the initial program briefing.

Following the accident, differing accounts of the normal aircraft operating heights were obtained from the various involved personnel, with a general consensus that the Super Cub operated above the R44. However, the investigation was unable to locate any documentation that specified the required operating height of either aircraft.

An analysis of recorded Global Positioning System (GPS) data from the Super Cub indicated that, in the 15 minutes prior to the collision, its operating height was about 500 ft AGL. Although the GPS data obtained from the R44 did not contain altitude information, the R44 pilot reported that his average operating height during the aerial spotting was about 250 to 350 ft AGL.

Neither the R44 nor the Super Cub had any means of directly measuring their height AGL. The R44 pilot's assessment of his height above the ground was derived visually.

Additional information

Collision recognition and reaction time

In 1983, the US Federal Aviation Administration (FAA) produced an advisory circular[18] on the risk of mid-air collisions. That circular included the results of a study that was undertaken by the US Navy to determine the time taken for pilots to recognise and react to a collision hazard.[19] The results of the US Navy study are summarised in the following table.

Table 1: Time to recognise and react to a collision hazard

Item	Time required (seconds)
See object	0.1
Recognise aircraft	1.0
Become aware of collision course	5.0
Decision to turn left or right	4.0
Muscular reaction	0.4
Aircraft lag time	2.0
Total	**12.5**

Fatigue assessment

The flying schedule for the culling program comprised four scheduled flights per day, each of about 2 hours duration. Suitable food, drink and resting accommodation were reported by the involved DEC personnel to be available to the pilots, and an emphasis was placed on the need for sufficient food intake and the maintenance of adequate hydration by all those involved in the culling operation.

The accident occurred after a total of about 7 hours flying, comprising three flights over a period of about 12 hours.

Despite the availability of sustenance and rest facilities, in the week before the accident, both pilots had worked long days carrying out other flying operations that required sustained physical and mental effort.

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18 Federal Aviation Administration (1983) *Pilot's Role in Collision Avoidance* (Advisory Circular 90-48C).

19 The results are based on an assessment of two Lockheed T-33 Shooting Star aircraft approaching directly towards each other.

The R44 pilot's hours worked in the days preceding the accident were analysed using two separate software programs. Those programs allowed the assessment of the potential for rostered hours of work to result in fatigue[20]. Neither analysis indicated that the pilot's work schedule would have been likely to result in fatigue leading to a significant performance decrement in task-related activities.

It was reported that the Super Cub pilot's activities in the period preceding the accident broadly reflected those of the R44 pilot. However, given that a detailed account of his movements over the preceding 2 weeks was not possible, a full fatigue analysis for the Super Cub pilot was unable to be carried out.

Risk assessment[21]

The risk assessment process involved the identification of possible sources of harm (hazards) associated with an activity and an evaluation of the potential for each of those hazards to produce an adverse outcome.

The potential impact of a given hazard was considered in terms of the likelihood of the hazard leading to an adverse outcome, and the magnitude of the potential consequences that may arise. Likelihood and consequence together form a measure of the risk posed by a hazard.

A risk assessment prior to the commencement of an activity or task, and prior to the implementation of a change associated with an activity, provides an opportunity to identify and mitigate those risks that are considered to be unacceptably high.

Cub cockpit visibility

An assessment of the field of view from the Super Cub's front seat cockpit was undertaken by the investigation. That assessment involved taking a series of digital photographs from the Super Cub pilot's approximate eye position,[22] and combining them to form a single, 360 degree panoramic image[23] (Figure 12). The area shown in blue on the panoramic image represents the unobstructed field of view from the front seat of the Super Cub.

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20 The programs used were FAID (www.faidsafe.com) and FAST (www.fatiguescience.com).

21 For additional information refer to the joint Australian and New Zealand Standard, AS/NZS 4360:2004 *Risk management*.

22 The accident aircraft differed from the Super Cub that was used to assess the field of view, in that it had a metal roof that restricted the field of view above the aeroplane.

23 The image was obtained by 'folding out/forward' the 360 degree view, to produce a two dimensional representation of the field of view from the front seat of the aircraft. Refer to Appendix B for more detail.

Figure 12: Field of view from the Super Cub's front seat

A second spotter, who participated in the Kennedy Range cull, described having good peripheral visibility from the rear cockpit of the accident aircraft, with limited visibility towards the front of the aeroplane. He also stated that the metal roof (not visible in Figure 12) obscured his field of view above the aeroplane, and that it extended forward to just above the pilot's head.

ANALYSIS

The accident occurred during feral goat culling operations in a Western Australian national park. The two aircraft involved, a Super Cub aeroplane and an R44 helicopter, collided in mid-air as the pilot of the helicopter was executing a climbing left turn in response to the Super Cub passing underneath his helicopter. The pilot and shooter occupants of the R44 had been aware that the Super Cub was approaching them at the same height from a distance of approximately 2 km, and the helicopter pilot was aware of the position of the aeroplane during the helicopter's climbing turn, but it appeared probable that the pilot and spotter occupants of the Super Cub did not see the helicopter.

The helicopter's main rotor blades struck the Super Cub's right wing, severing the lift struts. The right wing of the aeroplane detached in flight and the Super Cub fell to the ground. The occupants of the Super Cub were fatally injured. The helicopter was able to land safely.

Mid-air collision

The climbing left turn by the R44 pilot at about the time the two aircraft passed each other resulted in the two aircraft coming into close proximity. The R44 pilot's in-flight assessment that the occupants of the Super Cub would not have been able to see the helicopter, and the available field of view from the cockpit as a consequence of the Super Cub's design, both suggested that the occupants of the Super Cub would have been unable to see the R44 from about the time that the pilot of the helicopter commenced the left turn.

Not having sighted the helicopter, and in the absence of any radio transmissions by either pilot, the Super Cub pilot was probably unaware of the R44 pilot's position and intentions. He would therefore have been manoeuvring in the belief that both aircraft were adequately separated.

The shifting ammunition container inside the R44 temporarily focussed the shooter's attention inside the cockpit and meant that, in the short period before the collision, only the R44 pilot was aware of the relative position of the two aircraft. The R44 pilot's account of the moments preceding the collision indicated that he did not recognise the collision risk until it was too late, making it difficult to comply with the Civil Aviation Regulations (CARs) relating to collision avoidance.

The R44 pilot's recollection of being unable to avoid the collision, and of being unable to level the helicopter in an effort to absorb the impact, were both consistent with the Federal Aviation Administration's (FAA) advisory circular *Pilot's role in collision avoidance*, which discussed the time required to recognise and react to a collision hazard.

The ATSB considered a number of factors, including the possibility of work-induced fatigue, which may have affected the R44 pilot's ability to recognise the collision hazard in sufficient time to take avoiding action. None appeared to be significant.

Possible Super Cub engine power loss

The examination of the Super Cub components that were recovered from the accident site indicated that the propeller was rotating, either under low power or windmilling, at the time of collision with terrain. The investigation considered the possibility that the Super Cub sustained an engine power loss immediately prior to the mid-air collision, and whether the reported abrupt climbing manoeuvre by the pilot of the Super Cub was in preparation for a forced landing.

In regard to the possibility for carburettor icing to have affected engine performance, the environmental conditions recorded at Gascoyne Junction at 1500, and existing at the time of the accident, suggested that engine power loss due to carburettor icing was unlikely.

Although the position of the fuel selector could not be determined, the pattern of full fuel loading used during the previous flights, the duration of the accident sortie, and the observation that fuel was leaking from the aeroplane wreckage after the impact with the ground, combined to indicate that fuel contamination, or an interrupted fuel flow prior to the mid-air collision, were unlikely.

However, subsequent to the mid-air collision, it was likely that the carburettor's operation would have been compromised due to the interruption of its fuel supply. If the right tank was supplying fuel to the engine at the time of the collision, the fuel flow to the carburettor would have been interrupted when that wing detached from the aircraft. Moreover, irrespective of which fuel tank was supplying the engine at the time of impact, the in-flight forces associated with the uncontrolled flight of the Super Cub following the collision could be expected to have similarly affected the fuel flow to the carburettor, and therefore its operation. Either impact-related affect on the operation of the carburettor, and therefore of the engine, would have been consistent with the rotation of the propeller with little or no power at ground impact.

The above considerations, in combination with the results of the engine examination and the R44 pilot's observation that the Super Cub out-climbed the climbing R44 made it unlikely that the Super Cub experienced an engine power loss prior to the mid-air collision.

Operating procedures

There were no formalised operating procedures detailing the conduct of multiple aircraft operations, including the assurance of aircraft separation, in relation to the goat-culling activities that were being undertaken at the time of the accident. The differing accounts of the normal operating heights of both aircraft by the personnel involved also indicated that operating heights were not clearly defined. Instead, there appeared to have been a reliance on the pilots of both aircraft maintaining a lookout for other aircraft, and taking avoiding action as necessary (the 'see-and-avoid' principle), together with a 'generally accepted' practice that each of the aircraft would operate at different heights.

The application of procedures that were consistent with the requirements of the Civil Aviation Safety Regulations (CASR) for the conduct of combined aircraft operations would have provided an operational framework for the combined Super Cub and R44 culling operation. A procedural framework comprising, for example, lateral separation minima, radio communication requirements, the designation of a

‘coordinating pilot’, and specified responses to abnormal situations, could have assisted the pilots to maintain adequate separation, and to respond appropriately once they knew separation had broken down.

FINDINGS

From the evidence available, the following findings are made with respect to the mid-air collision that occurred within the Kennedy Range National Park, WA on 13 February 2008, and involved Robinson Helicopter Company R44 Raven, registration VH-ZDP and Piper Aircraft Corporation PA-18 Super Cub, registration VH-OUS. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- At about the time the two aircraft initially passed each other, the R44 pilot initiated a climbing left turn that resulted in the two aircraft coming into close proximity.
- The Super Cub occupants were probably unable to see the R44 during the period beginning at or about the time the helicopter commenced the climbing left turn until the collision.
- There was no alerting radio call to advise the Super Cub occupants of the R44 position and intentions.
- Only the R44 pilot was aware of the relative position of the two aircraft.
- The Super Cub pilot's manoeuvre resulted in the two aircraft converging.
- The R44 pilot did not recognise the collision risk until there was insufficient time to prevent contact with the Super Cub.
- There were no formalised operating procedures detailing the conduct of multiple aircraft culling operations, including the assurance of aircraft separation, that would have assisted the pilots to maintain separation from each other. *[Safety issue]*

Other key findings

- The R44 pilot's work schedule was unlikely to have resulted in work-induced fatigue leading to a significant performance decrement in his ability to operate the helicopter.

SAFETY ACTION

The safety issue identified during this investigation is listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Lack of procedures for ensuring separation

Safety issue

There were no formalised operating procedures detailing the conduct of multiple aircraft culling operations, including the assurance of aircraft separation, that would have assisted the pilots to maintain separation from each other.

Safety action taken by the R44 operator

Following a review of operations following the accident, the R44 operator advised that a Job Safety Analysis (JSA) risk assessment process was introduced. The JSA process is conducted prior to all flying activities undertaken by the operator to aid in the identification and mitigation of the associated risks.

Safety action taken by the Super Cub operator

The Super Cub operator advised that, following the accident, a briefing was provided to all of the operator's pilots that emphasised the need to maintain separation with other aircraft through the use of assigned levels, radio communication, and the maintenance of situational awareness. That briefing, which was delivered by the chief pilot, was also incorporated as part of the operator's induction program for newly employed pilots.

The operator also advised that procedures detailing the conduct of close proximity operations have been included in the company operations manual, and that a JSA risk assessment process will be introduced and applied to all company flying activities.

Safety action taken by the WA Department of Environment and Conservation

In response to this accident, the WA Department of Environment and Conservation (DEC) conducted a risk assessment of all aviation activities conducted by the department, including the conduct of aerial culling programs. That assessment identified a number of areas of high risk associated with the current conduct of

aviation activities within the DEC, and led to the preparation of a business case and feasibility study in support of the following potential reforms:

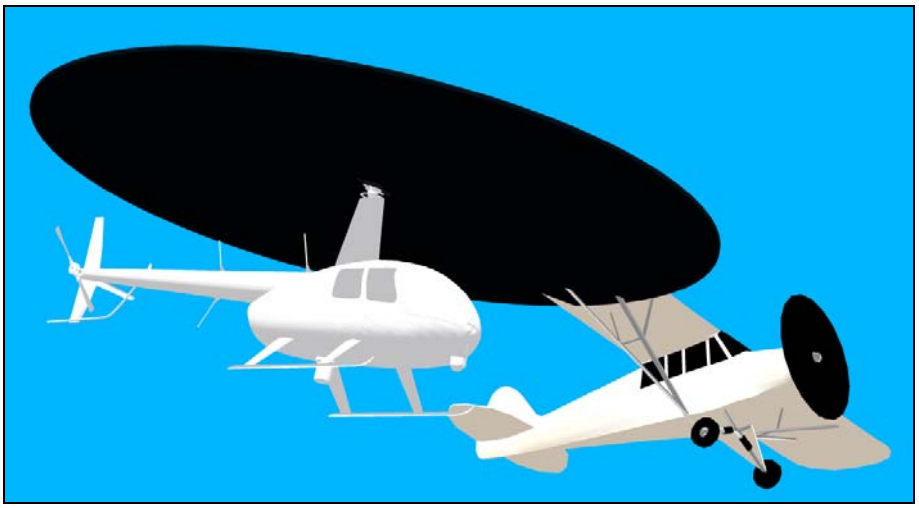
- The appointment of an Aviation Manager with state-wide responsibility and oversight for quality assurance in aviation and aircraft operations in DEC.
- The formation of an Aviation Reference Group to provide advice on aviation services within DEC.
- An aviation organisational structure that integrates and coordinates state-wide aviation and aircraft operations in DEC.
- The development and implementation of a DEC aviation policy that provides the approved framework for state-wide air operations conducted by, or on behalf of, the department.
- The adoption of an aviation 'safety management system' in DEC incorporating project and site-specific safety management plans, and written standard operating procedures.
- The development of comprehensive training for aircrew and DEC staff engaged in aircraft operations.
- Planning for the optimum aircraft mix to meet the expanded demand for aviation services in DEC.

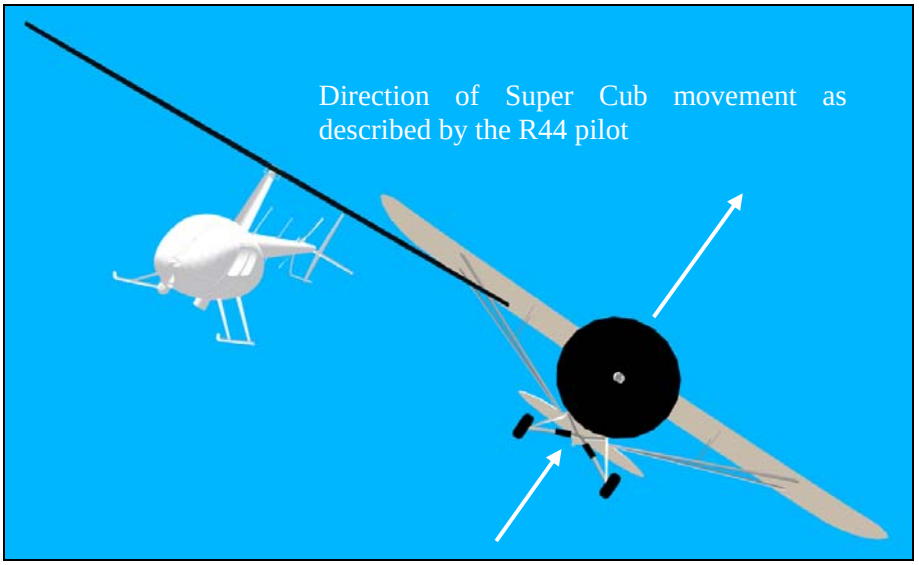
Safety action taken by the Department of Agriculture and Food, WA

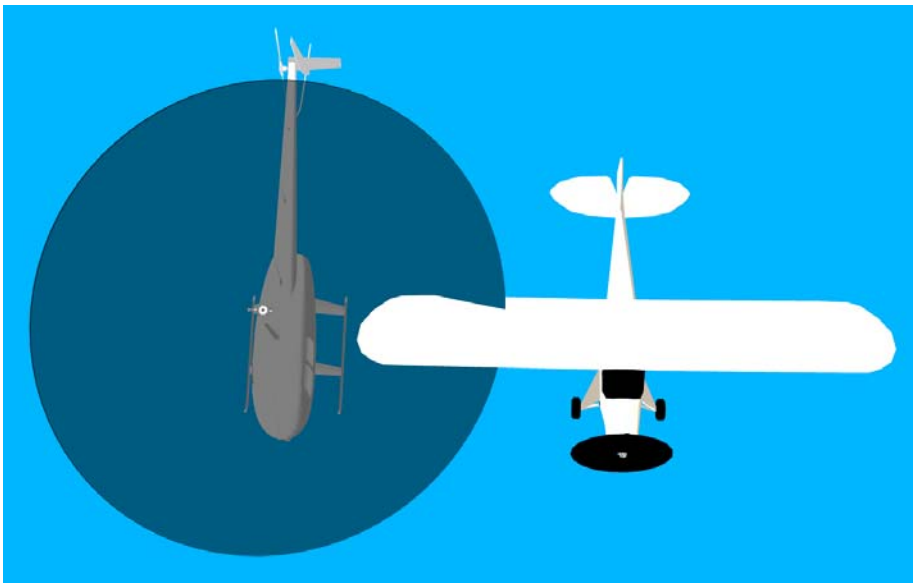
Following the mid-air collision, the Department of Agriculture and Food, WA (DAFWA) conducted an internal review of remote area aerial guidelines and procedures related to multiple aircraft operations. The recommendations from that review included the:

- introduction of a minimum separation standard of 200 m horizontally and 200 ft vertically between aircraft that were involved in multiple aircraft operations
- investigation of the feasibility of fitting proximity alarms to all aircraft involved in multiple aircraft operations
- amendment of existing guidelines to emphasise the need for continuous communication, and the conduct of operations with reference to the same Global Positioning System (GPS) waypoint(s), when conducting multiple aircraft operations
- clearly defined division of responsibility for all future operations involving other government departments through the use of formal memorandums of understanding
- review and approval of the documented plan and procedures/guidelines prior to the conduct of all aerial operations involving DAFWA personnel
- review of whether aerial culling programs should be conducted in the hotter months of the year.

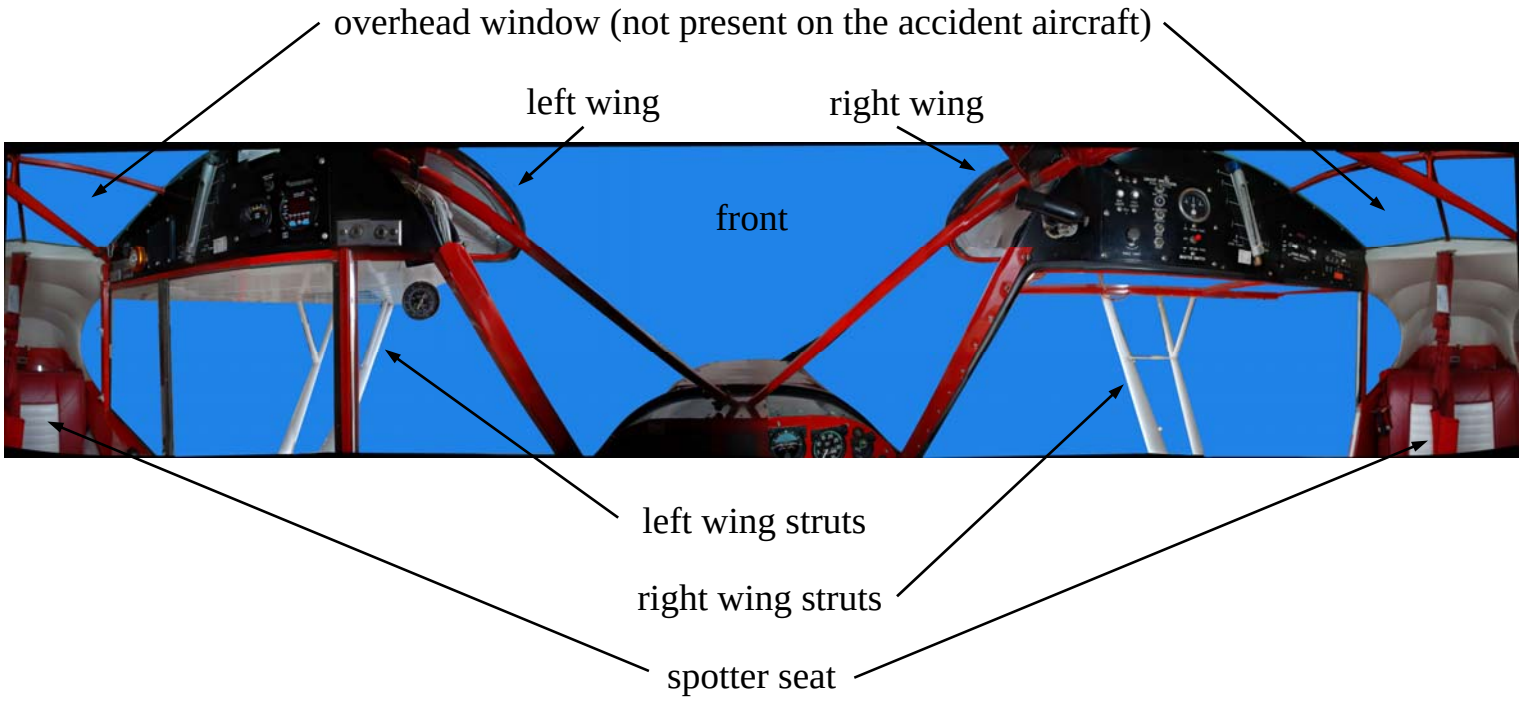
APPENDIX A: RELATIVE AIRCRAFT POSITIONS AT IMPACT







APPENDIX B: CUB PILOT FIELD OF VIEW



APPENDIX C: SOURCES AND SUBMISSIONS

Sources of information

The sources of information during the investigation included the:

- involved aircraft operators
- R44 pilot
- R44 shooter
- Western Australian Department of Environment and Conservation (DEC)
- Department of Agriculture and Food, Western Australia (DAFWA)
- available R44 and Super Cub onboard Global Positioning System (GPS) data
- Super Cub and R44 maintenance documentation
- R44 manufacturer's *Pilot Operating Handbook*
- Geoscience Australia website
- Bureau of Meteorology (BoM)
- US Federal Aviation Administration's (FAA) *Advisory Circular 90-48C*
- Civil Aviation Safety Authority (CASA)
- relevant civil aviation regulatory documentation.

Submissions

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

A draft of this report was provided to CASA; DEC; the DAFWA; the R44 operator, pilot and shooter; and the Super Cub operator.

Submissions were received from the operator of the Super Cub, CASA, DEC and DAFWA. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.