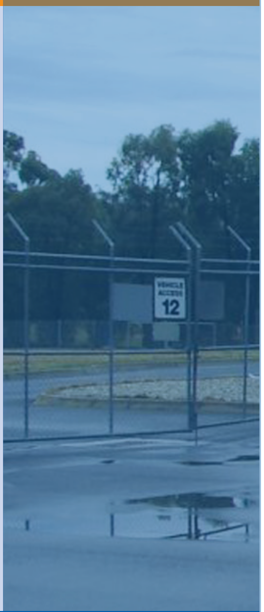
Australian Transport Safety Bureau



ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2009-030
Final

Wirestrike
24 km NNE of Albury Aerodrome
New South Wales
23 June 2009
VH-CAP
Bell Helicopter Company 206B
JetRanger III

Australian Government

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Figure 1: Airservices Australia
Cover photo, Figures 2 and 5 to 8: Campbell Paton
Figure 3: Bristol Aerospace Limited

Abstract

At about 1100 Eastern Standard Time on 23 June 2009, a Bell Helicopter Company 206B JetRanger III helicopter, registered VH-CAP commenced agricultural spraying operations at a property located 24 km north–north-east of Albury Aerodrome, New South Wales. At 1223 the pilot repositioned to commence an impromptu spray run that resulted in the helicopter flight path crossing a powerline that was known to the pilot.

The pilot reported that during the impromptu spray run, he was preoccupied with a request from the property owner to modify the planned spray sequence and forgot about the wire until he sighted it a short distance ahead. In response, the pilot initiated a climb to avoid the wire. He heard the helicopter contact the wire and felt the wire arrest the forward movement.

Although the helicopter was fitted with wire-strike protection system (WSPS) equipment, the wirestrike was outside the strike angle and cable span design parameters of the WSPS. The investigation was unable to determine whether the WSPS might have operated as intended, had the wire continued its initial movement towards the cutter blades before itself breaking.

The pilot's last recollection was seeing the ground rapidly approaching. He regained consciousness an unknown period of time later, still securely restrained in the wreckage. He managed to extricate himself and notify his ground crew. The pilot sustained minor injuries.

The investigation found that the inherent difficulty in visually detecting the wire, combined with the operating groundspeed required for chemical application meant that the pilot did not have sufficient time to avoid the wirestrike.

Although no safety issues were identified as a result of this investigation, the protection afforded by the pilot's helmet and the secure restraint offered by the pilot's four-point harness, probably prevented serious, if not fatal injury. Operators and crew would benefit from the consideration of the use of flying helmets, and when feasible, installation of four-point harnesses in their aircraft; particularly during inherently higher risk operations.

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.

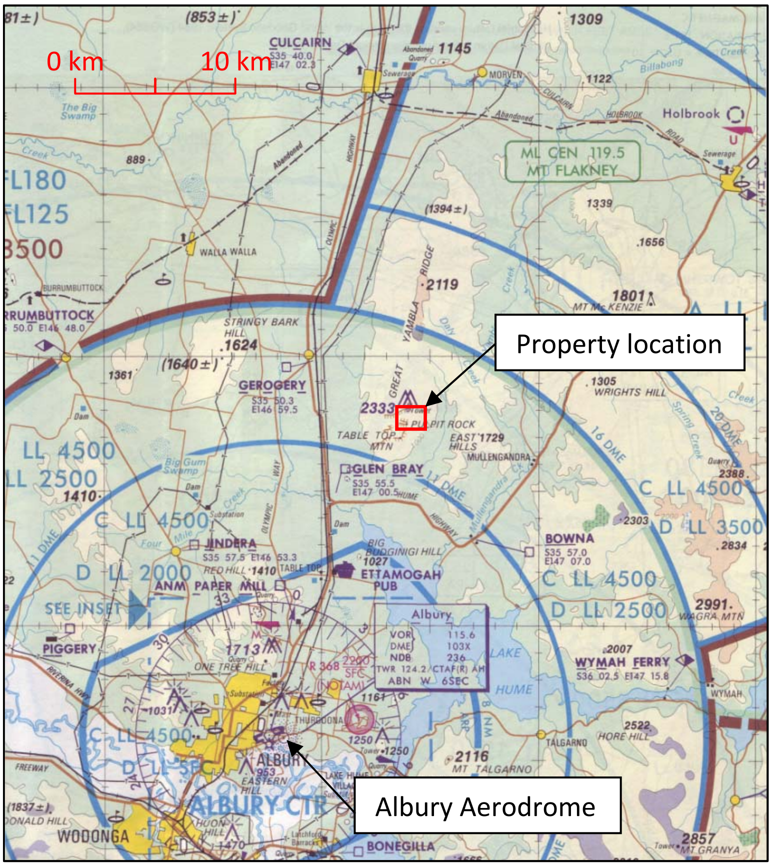
FACTUAL INFORMATION

History of the flight

At about 1100 Eastern Standard Time[1] on 23 June 2009, a Bell Helicopter Company 206B JetRanger III (Bell 206B-3) helicopter, registered VH-CAP (CAP), commenced agricultural spraying operations at a property located 24 km north-north-east of Albury Aerodrome, New South Wales (Figure 1). The helicopter had been repositioned earlier that morning from its base located about 25 km south-east of Albury Aerodrome.

The pilot reported that on arrival at the property he conducted an aerial survey of the area with the property owner. The survey flight was carried out to confirm the areas to be sprayed and identify potential hazards, including any wires, within the spraying area. Following that survey, the pilot landed and the property owner exited the helicopter. The pilot then commenced spraying the higher elevations of the property, returning to land a number of times during the flight to load more chemical and to resolve minor issues with the spray equipment.

Figure 1: Area map



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

The pilot stated that while he was operating on the high ground he was contacted by the property owner via ultra high frequency radio with a request that he commence spraying some of the lower elevations sooner than planned. The pilot reported that the property owner had relocated stock to facilitate the spraying of the lower ground and was concerned that possible rainfall would delay both spraying and the return of the stock to that area.

The pilot had planned to spray the property from the higher elevations down to the lower ground and stated that in response to the radio call, he began formulating a plan to accommodate the property owner's request while continuing to apply the current load of chemical. At 1223 the pilot completed spraying the south-western area of the property and, noting that he had chemical remaining, decided to relocate and complete an additional spray run prior to taking a lunch break. The selected area for the run crossed a powerline that was known to the pilot both from previous operations on the property and from having been identified during the survey flight with the property owner that morning. The pilot had also conducted two spray runs across that wire during the morning's flight.

The pilot reported that he repositioned the helicopter and commenced the final run while still considering the amended spray plan. He did not recall thinking about the wire during the spray run until he observed it a short distance ahead at about eye level. In response, the pilot fully raised the collective lever[2] and initiated a climb to avoid the wire. Shortly after, he heard the helicopter contact the wire and felt the wire arrest the helicopter's forward movement. The pilot's last recollection of the accident sequence was seeing the ground rapidly approaching, though he could not recall the orientation of the helicopter. The pilot regained consciousness an unknown period of time later, still securely restrained in the wreckage of the helicopter by his harness. He managed to extricate himself and notify his ground support crew who in turn contacted emergency services.

The pilot sustained minor injuries and the helicopter was seriously damaged.[3]

Personnel information

The pilot held a Commercial Pilot (Helicopter) Licence that was issued on 16 March 2005 and was endorsed on the Bell 206 helicopter type. The pilot also held a Class 1 Medical Certificate without restriction, and a Grade 2 helicopter agricultural rating that, together with the required approvals held by the operator, permitted the conduct of the spraying operation. The pilot had also completed low-level flying training in accordance with Civil Aviation Order 29.10 and reported that he had conducted a number of training courses relating to helicopter operations in the vicinity of wires.

According to entries in the pilot's flying logbook, the pilot's total aeronautical experience at the time of the occurrence was 2,083 flying hours, of which 1,661 hours were in Bell 206 helicopters. The pilot's most recent flight review was conducted on 13 April 2008 in the form of helicopter conversion training for the issue of an AS350 helicopter class endorsement.

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

[3] The *Transport Safety Investigation Regulations 2003* define 'serious damage' as including the 'destruction of the transport vehicle.'

Aircraft information

The Bell 206B-3 is a five-seat, single main and tail rotor-equipped helicopter that is powered by a gas turbine engine, and equipped with skid-type landing gear. The accident aircraft was fitted with chemical spray equipment and a wire-strike protection system (WSPS) (Figure 2).

Figure 2: VH-CAP without chemical spray equipment fitted

The WSPS consisted of a windshield deflector and cutter assembly that was mounted to the roof of the helicopter, and a second cutter assembly that was attached to the lower fuselage. Forward movement of the helicopter, combined with the action of the deflectors was intended to sever any wire that was struck by the helicopter by guiding it into high tensile steel cutter blades that were located at the base of the upper and lower assemblies.

The lower deflector was fitted with a breakaway tip that was riveted to the lower cutter assembly (Figure 3). The rivets were designed to shear in the event of ground contact to prevent damage to the helicopter. The length of the breakaway tip varied depending on whether the helicopter was fitted with high or low skids. CAP was equipped with high skids and the long breakaway tip.

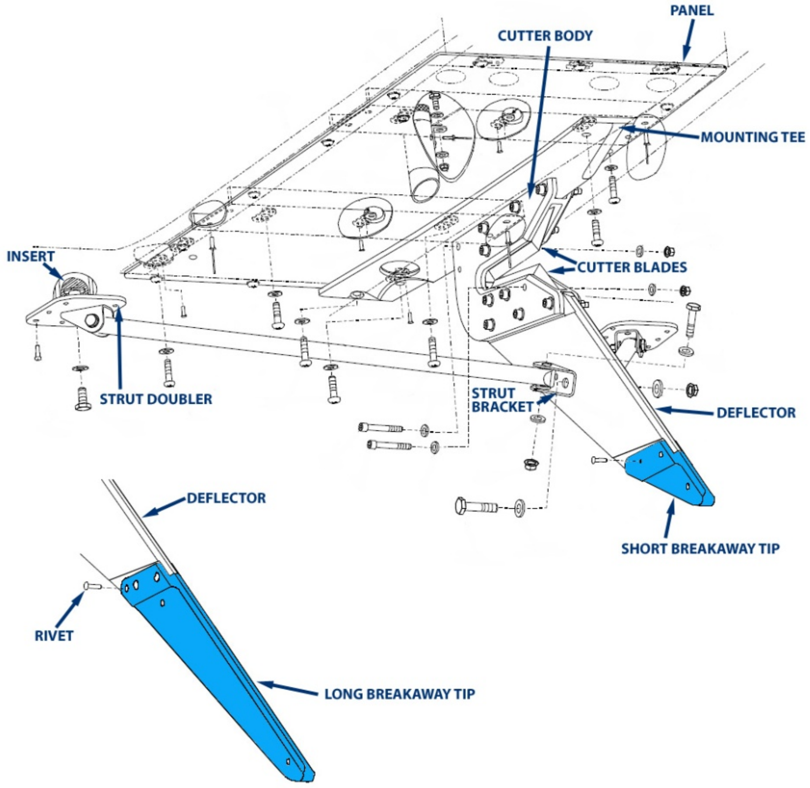
The manufacturer of the WSPS advised that the design of the system was based on the following operational criteria:

- helicopter forward velocity range from 24 km/h to 96 km/h
- impact angle between the flight path and the wire (strike angle) from 60° to 90°
- aircraft pitch attitudes at impact from 5° nose down to 5° nose up
- angle of yaw at impact; 30° at 24 km/h and 15° at 96 km/h
- critical wire diameter of 10.0 mm (1 x 7 steel strand wire)
- cable spans of up to 61 m.

With regard to the effectiveness of the system, the manufacturer stated:

> Forward speed, cable tension, cable angle, strike angle and pilot reaction are all factors that affect the protection the system provides.

Figure 3: Lower cutter assembly



Wreckage and impact information[4]

The accident occurred over sloping terrain at an elevation of about 1,650 ft above mean sea level (AMSL) (Figure 4). The lower guide of the WSPS contacted the powerline ‘earth’ wire as the helicopter was travelling along the sloping terrain at about 15 m above the ground. The wire cut into the lower guide before failing and separating at some point during the accident sequence (Figures 5 and 8).

Significant damage to the helicopter’s structure behind the rear cabin indicated that the majority of the energy associated with the ground impact was absorbed in that area (Figures 6 and 7). A number of components, including the main rotor, engine and tail boom detached during the accident sequence; however, the forward cabin structure and pilot’s four-point harness restraint remained intact.

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4 The Australian Transport Safety Bureau did not attend the accident site immediately following the accident notification. Examination of the wreckage was conducted following its removal from the site by third-party support.

Figure 4: Helicopter approach path towards the wire[5]

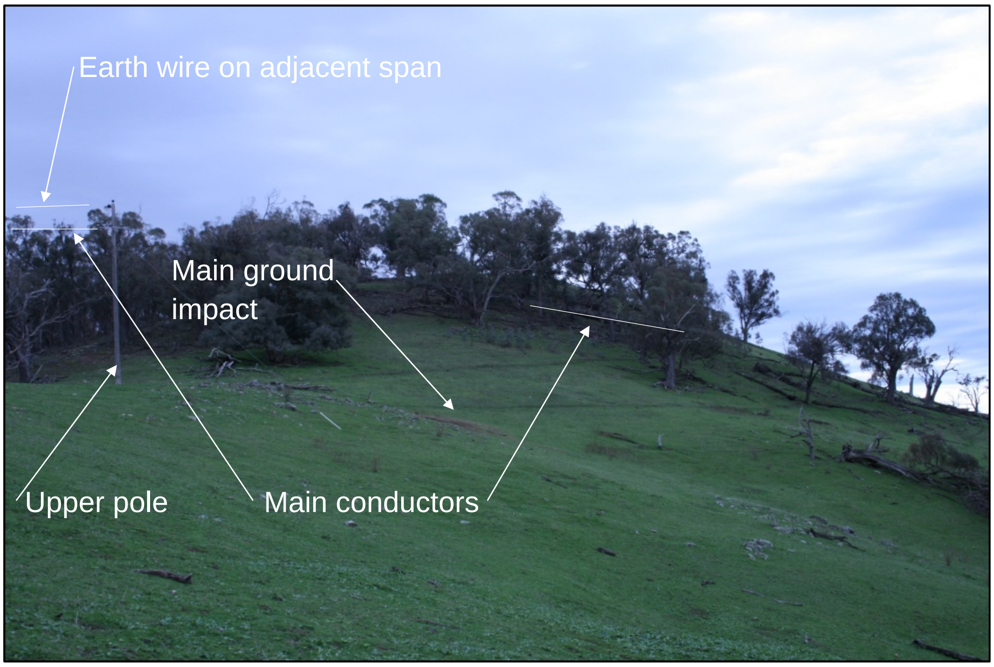

Figure 5: Accident site

5 This image was taken from the ground, about 15 m below the pilot's viewpoint.

Figure 6: Accident site prior to the movement of the wreckage

Figure 7: Rear structure impact damage

The WSPS lower deflector breakaway tip, pilot helmet and recorded Global Positioning System (GPS) information were retained for technical examination.

Examination of recovered components

Wire-strike protection system lower deflector

Examination of the breakaway tip[6] indicated that the helicopter impacted the wire at the lower extremity of the tip. The wire slid up the deflector towards the cutter blades, before embedding in the vicinity of the riveted join (Figures 8 and 9). There was evidence that, following the initial contact with the wire, the helicopter remained in contact with and travelled along the wire. That resulted in the localised heating of the aluminium deflector, increasing the likelihood that the wire might penetrate the deflector.

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6 The breakaway tip detached from the lower deflector during the removal of the helicopter wreckage from the accident site.

Figure 8: Penetration of the lower deflector by the wire

Examination of the hole in the deflector that was created by the wire indicated that the helicopter contacted the wire at a strike angle of 40°. The hole appeared to be relatively symmetrical in shape, and was about 6 to 7 mm in diameter, consistent with that of an earthing wire.

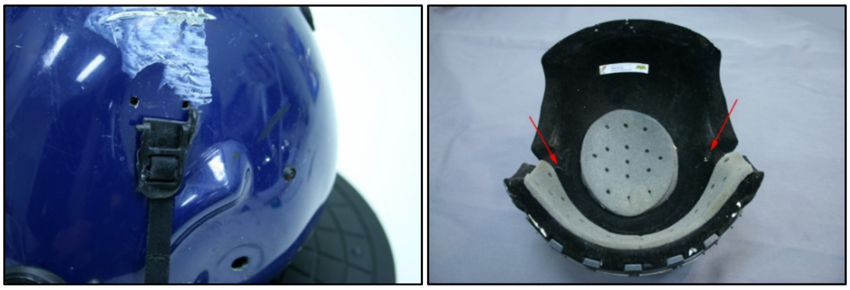
Following technical examination of the breakaway tip by the Australian Transport Safety Bureau (ATSB), it was forwarded to the WSPS manufacturer for assessment. The manufacturer concluded that the helicopter probably contacted the wire outside of the WSPS design parameters, and that the cable penetrated the WSPS in the vicinity of the discontinuity between the breakaway tip and the deflector (Figure 9) due to a combination of the strike angle and the helicopter's orientation.

Figure 9: Penetration of the lower deflector by the wire

Pilot's flying helmet

The pilot's helmet exhibited impact damage on the right side in the region of the ear cups. Additionally, cracks were observed on either side of the helmet in the region adjacent to the ear cut outs. That was indicative of the flexing of the foam from the front and back of the helmet (Figure 10). The degree of damage to the helmet indicated that the pilot sustained a significant impact to the front and possibly the back of the head during the accident sequence.

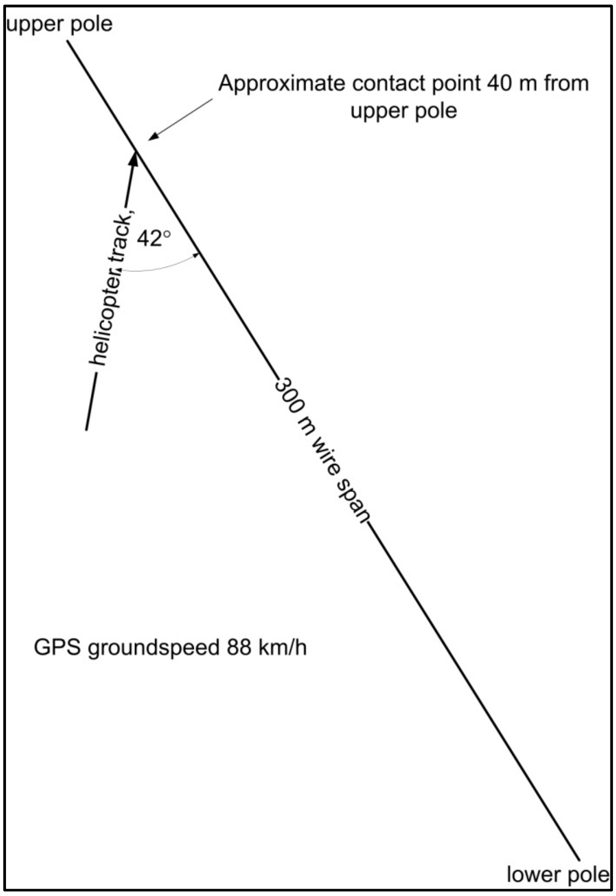
Figure 10: Helmet impact damage (arrows indicate crack locations)



Recorded Global Positioning System information

The helicopter was equipped with differential GPS equipment that provided guidance to the pilot during the application of the chemical. Examination of the recorded GPS data log indicated that about 1 second before contacting the wire, the helicopter had a groundspeed of 88 km/h and was operating about 15 m above the ground. The data also indicated that the helicopter contacted the 300 m span of wire about 40 m displaced from the upper pole at a strike angle of about 42° (Figure 11).

Figure 11: Helicopter position at the time of the wirestrike



Additional information

Human performance limitations

Limitations of vision

The factors that can affect vision were discussed in a Royal Australian Air Force (RAAF) aviation medicine text that was developed for use by military aircrew.[7] That text highlighted that:

> Visual acuity is the ability to discriminate detail or a measure of the eyes ability to focus. The normal eye in ideal conditions can resolve detail which subtends an angle of about 30 seconds of arc[8]. Normal vision is described as 6/6 (or 20/20 in American notation, which is expressed in feet). That is, at 6 meters distance, the subject can discriminate one minute of arc[9]...Visual acuity can be affected by a number of factors such as atmospheric dust and haze, cleanliness of glasses, visors or windscreens, glare and of course the focussing power of the eye... Contrast between an object and its background will determine how easily you can discriminate that object.

The ability to resolve detail at an angle of 30 seconds of arc is equivalent to detecting an object 1 cm high from a distance of about 69 m.

The RAAF aviation medicine text discussion of the difference in visual acuity between central and peripheral vision included that:

> Using central vision with normal eyesight, one should be able to see a 2 metre (7 foot) disc at about 11km (7 miles). Once you get outside an arc of about plus or minus 10 degrees from your central vision, the same disc would only be visible at a range of just over 1 km or about 0.7 miles. So for optimum acuity you must use your central vision. This has important implications for mid-air collision avoidance and visual search patterns and methods.

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7 SQNLDR G. Szczecinski, Dr G. Cable *Aviation Medicine for Aircrew.* Royal Australian Air Force Institute of Aviation Medicine.

8 30 seconds of arc is an angular measure equivalent to 1/120th of a degree.

9 1 minute of arc is equivalent to 1/60th of a degree. This equates to detecting an object 1 cm high from a distance of 34 m.

Perception and reaction time

The RAAF aviation medicine text also listed the following times taken to recognise and react to a hazard:

> **Perception Time**. It takes a finite amount of time for an object to be detected, recognised, a decision made on an action, and then for that reaction to be initiated. Table 7-1 lists the expected times for these events to happen. It can take up to 5.5 seconds for the process to be completed.

Process	Time (Seconds)
Detect, visualise, recognise	1.0
Decide what to do	2.0
Initiate action	2.5
Total	**5.5**

Table 7-1. Perception and Reaction Time

In 1983, the United States (US) Federal Aviation Administration (FAA) produced an advisory circular[10] that 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 posed by an approaching aircraft.[11] The results of the US Navy study indicated that up to 12.5 seconds can be taken to recognise and react to a collision hazard.

The range of perception-reaction times obtained by these two studies was consistent with other literature on hazard avoidance.[12]

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

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

[12] Leibowitz, H.W. (1988). The Human Senses in Flight. In *Human Factors in Aviation* Ed Wiener E.L. & Nagel D.C. Academic Press San Diego CA p.85

ANALYSIS

Wirestrike

The pilot's impromptu decision to reposition and apply the remaining chemical resulted in the helicopter's flight path crossing the wire. Although the pilot was aware of the location of the wire, having flown over it earlier that day, his preoccupation with managing the change of plan for spraying the property reduced his awareness of the wire. The effect was that during the spray run, he was not alerted to the presence of the wire and therefore its avoidance relied solely on visual detection.

Based on the recorded Global Positioning System groundspeed and the distance at which, under ideal conditions, the wire would be visually detectable, the pilot would have had about 2.8 seconds from sighting the wire until the wirestrike. The low contrast offered by the background trees, together with other possible visual limitations such as not observing the wire using central vision, perhaps as a result of not looking at the wire at the time, would have increased the difficulty of seeing the wire and reduced the available time to take avoiding action.

The time required to detect and avoid a midair collision hazard between two aircraft could be expected to differ from the time required to detect and avoid a wire. However, the indicative time frame of 5.5 to 12.5 seconds is significantly longer than the time that was available to the pilot in this occurrence. This is consistent with the pilot's account that he did not have sufficient time to avoid the wire, and indicates that the avoidance of wires using the see-and-avoid method is not effective for operations in the low-level environment.

The helicopter contacted the wire outside the strike angle and cable span design parameters of its wire-strike protection system (WSPS). The strike angle, likely resultant sliding movement between the helicopter and the wire and the orientation of the helicopter, probably contributed to the penetration of the wire into the breakaway tip. The investigation was unable to determine whether the WSPS might have operated as intended, had the wire continued its initial movement towards the cutter blades.

Accident survivability

Examination of the helicopter wreckage indicated that the most likely reason for the pilot's survival was the absorption of the ground impact energy by the rear section of the helicopter and the maintenance of the structural integrity of the cockpit area, including the pilot's harness anchor points. This provided a survivable space which, combined with the protection afforded by the pilot's helmet and the secure restraint of the four-point harness, probably prevented serious, if not fatal injury. The low operating altitude, combined with the retarding effect of the wire as described by the pilot may also have reduced the potential for severe injury by reducing the overall ground impact energy.

FINDINGS

From the evidence available, the following findings are made with respect to the wirestrike that occurred 24 km north–north-east of Albury Aerodrome, New South Wales on 23 June 2009 and involved Bell Helicopter Company B206B-3, registration VH-CAP. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The pilot conducted an impromptu spray run that resulted in the helicopter’s flight path crossing the wire.
- The pilot's preoccupation with the property owner's request to modify the planned spray sequence reduced his attention on the spraying task, including the presence of the wire.
- The pilot forgot about the wire that crossed the intended flight path.
- The wire was inherently difficult to see.
- The operating groundspeed for chemical application meant that the pilot could not see the wire in sufficient time to avoid the wirestrike.

Other key findings

- The helicopter contacted the wire outside the strike angle and cable span design parameters of its wire-strike protection system.
- The protection afforded by the pilot’s helmet and the secure restraint of the four-point harness probably prevented serious, if not fatal injury.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- the pilot and owner of VH-CAP
- the wire-strike protection system manufacturer
- the Australian Maritime Safety Organisation Rescue Coordination Centre
- Transportation Safety Board of Canada (TSB).

References

SQNLDR G. Szczecinski, Dr G. Cable *Aviation Medicine for Aircrew*. Royal Australian Air Force Institute of Aviation Medicine.

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

Leibowitz, H.W. (1988). The Human Senses in Flight. In *Human Factors in Aviation* Ed Wiener E.L. & Nagel D.C. Academic Press: San Diego CA p.85.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the 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 and owner of the helicopter, the Civil Aviation Safety Authority (CASA), the wire-strike protection system manufacturer and the TSB.

Submissions were received from CASA and the wire-strike protection system manufacturer. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Wirestrike, 24 km NNE of Albury Aerodrome, New South Wales
23 June 2009, VH-CAP, Bell Helicopter Company 206B JetRanger III