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Wire-strike Accidents in General Aviation: Data Analysis 1994 to 2004

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Wire-strike accidents in general aviation: data analysis 1994 to 2004

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Abstract

Wire strikes are a significant safety concern for general aviation (GA) operations. Wire strikes may result in fatalities and/or the destruction of an aircraft. This research analyses the characteristics of GA wire-strike occurrences using aviation accident and incident data collected by the Australian Transport Safety Bureau (ATSB). The analysis found that 117 wire-strike accidents and 98 wire-strike incidents were reported between 1994 and 2004. The rate of wire-strike accidents reported per 100,000 hours flown ranged from around 0.9 in 1997 and 1998 to 0.1 in 2003. The figures suggested a downward trend beginning in 1998, with a return to previous accident rates in 2004. Reported wire-strike incidents were primarily in only two of the statistical groups used by the ATSB for investigative purposes – aerial agriculture operations and other aerial work. The majority of wire-strike accidents were associated with aerial agriculture operations (75 accidents or 64 per cent). The findings reinforce the clear danger to pilots flying at low level because of wires, particularly when conducting aerial agriculture operations and other aerial work.

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EXECUTIVE SUMMARY

The aim of this study is to provide an analysis of wire-strike accidents and incidents. This should increase knowledge and insight in the Australian aviation community and improve safety in low-level flight.

A search of the ATSB accident and incident database identified 117 wire-strike accidents and 98 wire-strike incidents between 1994 and 2004. The rate of wire-strike accidents per 100,000 hours flown ranged from around 0.9 in 1997 and 1998 to 0.1 in 2003. The figures suggested a downward trend from 1998 to 2003, but in 2004 the rate increased to 0.55.

There were 240 people involved in the 117 wire-strike accidents reported between 1994 and 2004. In almost half of these accidents the occupant received some degree of injury. There were 45 people fatally injured, 21 seriously injured, and 44 who received minor injuries.

Reported wire-strike accidents and incidents were restricted to GA operations, primarily in only two of the statistical groups used by the ATSB for investigative purposes – aerial agriculture operations and other aerial work[1]. The majority of wire-strike accidents occurred in the aerial agriculture operations category (75 accidents or 64 per cent). The other aerial work category recorded 19 per cent of all accidents (22 accidents) and the private and business flying category recorded 15 per cent (17 accidents). One accident was recorded in the charter category and two were recorded in the flying training category.

Fixed-wing aircraft were involved in 56 per cent of wire-strike accidents and rotary-wing aircraft were involved in 44 per cent. In the absence of specific data on low-level operations, analysis of risk exposure levels for fixed-wing and rotary-wing operations was not possible.

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[1] See section 2.3 for definitions of the ATSB statistical groups.

ABBREVIATIONS

AGL	Above ground level
ATSB	Australian Transport Safety Bureau
BASI	Bureau of Air Safety Investigation
BTRE	Bureau of Transport and Regional Economics
CAR	Civil Aviation Regulations
GA	General aviation
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
MTOW	Maximum take-off weight
PMA	Prior moving average
RAAF	Royal Australian Air Force
RPT	Regular public transport
SWER	Single wire earth return
TSI Act	Transport Safety Investigation Act
VFR	Visual flight rules
VHF	Very high frequency
WSPS	Wire-strike protection system

1 INTRODUCTION

The aim of this study is to provide an analysis of wire-strike accidents and incidents to the Australian aviation community to increase knowledge and insight towards improved safety in low-level flight. A search of the ATSB accident and incident database identified 117 wire-strike accidents and 98 wire-strike incidents between 1994 and 2004. The rate of wire-strike accidents per 100,000 hours flown ranged from around 0.9 in 1997 and 1998 to 0.1 in 2003. The figures suggested a downward trend beginning in 1998, with a return to previous accident rates in 2004.

Wire strikes are associated with low-level flight, including the phases of landing and takeoff. While the hazards of low-level flight are recognised by the aviation industry, some aerial tasks require aircraft to be flown at very low levels. For example, most aerial agriculture operations and other aerial tasks such as mustering and powerline patrols are carried out below 500 feet above ground level (AGL).

In some cases the consequences of a wire-strike will be minor; for example, the propeller of a fixed-wing aircraft may cut an unseen wire, or a helicopter pilot may notice the wire in sufficient time to manoeuvre away. In less forgiving circumstances the wire may snare the aircraft, resulting in an accident that could cause the destruction of the aircraft and the possible injury or death of the occupants.

Despite research at the flight planning stage, reconnaissance of the proposed 'low-flying area' prior to the operation and a constant lookout during flight, wires are often difficult to detect. The likelihood of a pilot seeing wires is determined by a number of factors including the number of wires, type of support structure, length of wire span, the environment and the background against which the pilot is viewing the wires. Importantly, there is evidence to suggest that many pilots have prior knowledge of the presence of wires before they strike them. This suggests that there are reasons, other than a lack of awareness, causing wire-strike accidents and incidents to occur.

1.1 Background to the research

This research was initiated in response to three wire-strike accidents involving helicopters associated with locust control operations:

- An accident involving a Bell 206B helicopter conducting aerial work near Forbes, New South Wales on 31 October 2004 in support of the Forbes area locust control campaign. The accident resulted in minor injuries to one passenger and extensive damage to the helicopter (ATSB Report: 200404285). The aircraft is pictured in figure 1.

- An accident involving a Bell 47G-4A helicopter preparing for a locust spraying operation near Mudgee, New South Wales on 1 November 2004. The accident resulted in minor injuries to the pilot and destruction of the aircraft (ATSB Report: 200404286).

- An accident involving a Bell 206B helicopter near Dunedoo, New South Wales on 22 November 2004 in support of the Dubbo area locust control campaign. The accident resulted in fatal injuries to the pilot and one passenger, serious injuries to another passenger, and extensive damage to the helicopter. (ATSB Report: 200404590). The aircraft is pictured in figure 2.

Figure 1. Bell 206B helicopter after striking powerlines during a locust control campaign near Forbes on 31 October 2004

Figure 2. Bell 206B helicopter after striking powerlines during a locust control campaign near Dunedoo on 22 November 2004

2 BACKGROUND

2.1 The Australian aviation industry

The Australian civil aviation industry can be divided into four main categories based on *Civil Aviation Regulations 1988*[2]. These are regular public transport (RPT), charter, aerial work and private operations. Civil aviation operations do not include military operations.

Regular public transport operations are those used for the commercial purpose of transporting persons generally, or transporting cargo for persons generally, for hire or reward in accordance with fixed schedules to and from fixed terminals over specific routes with or without intermediate stopping places between terminals[3]. Charter operations are those that carry passengers or cargo for hire or reward and either are not on fixed schedules or are not available for use by persons generally[4].

Aerial work is sub-divided as:

- aerial surveying;
- aerial spotting;
- agricultural operations;
- aerial photography;
- advertising;
- flying training;
- ambulance functions;
- carriage of goods for the purposes of trade other than on fixed schedules; and
- any other purpose that is substantially similar to those specified above[5]**.**

Private operations include the personal transportation of the aircraft owner, operations for purposes that do not include remuneration and those components for flying training relating to endorsement of an additional type or category of aircraft in a pilot licence[6].

2.2 ATSB accident and incident database

The ATSB is responsible for the independent investigation of accidents and incidents involving civil aircraft in Australia. The ATSB's aviation accident and incident database captures data predominantly from accidents and incidents involving RPT and GA aircraft. Some data on sport and military operations are included in the database.

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[2] Civil Aviation Regulations 1988 (CAR) 2 (6).

[3] CAR 206 (1) (c) and CAR 2 (7) (c).

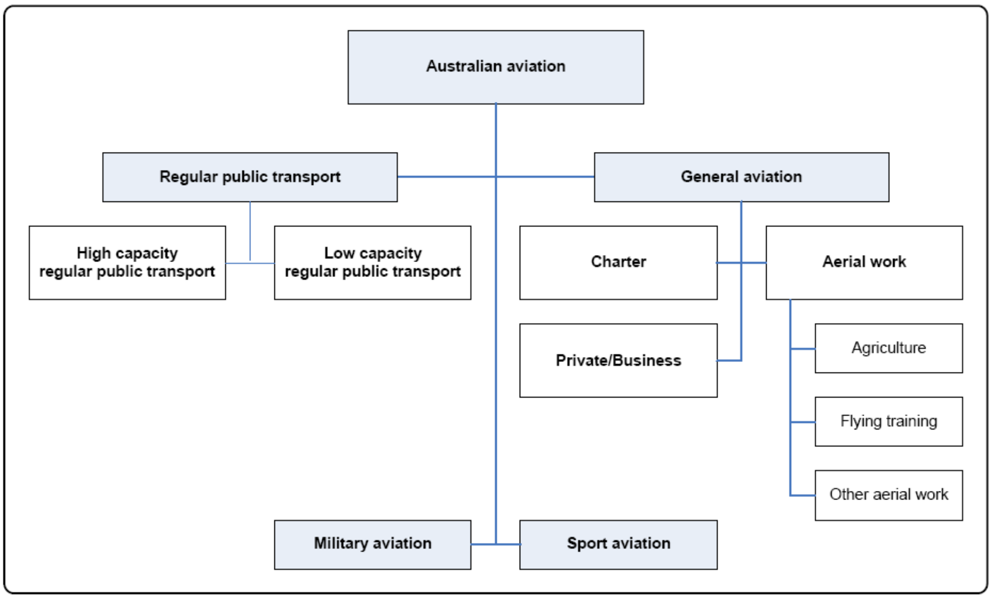
[4] CAR 206 (1) (b) and CAR 2 (7) (b).

[5] CAR 206 (1) (a) and CAR 2 (7) (a).

[6] CAR 2 (7) (d).

Investigations into accidents involving sport operations (eg ultralights, microlights, gyrocopters, gliders and hang gliders) will only be conducted if it benefits future safety and sufficient resources are available (ICAO, 2003). Military operations are generally overseen by military safety authorities.

Figure 3. ATSB statistical groups for the Australian aviation industry



For statistical purposes, the ATSB divides the Australian aviation industry into several different groups. As shown in figure 3, the two major groups are RPT and GA, with RPT divided into high capacity and low capacity operations and GA divided into charter, private[7] and business, and aerial work. Aerial work includes operations involving agriculture, flying training and other aerial work. The main statistical groups used in this report include:

Regular public transport

Regular public transport operations refer to air transport operations used for the commercial purpose of transporting persons generally, or transporting cargo for persons generally. These operations are conducted for hire or reward in accordance with fixed schedules to and from fixed terminals over specific routes with or without intermediate stopping places between terminals[8].

- **High capacity RPT**

  A high capacity aircraft used for RPT operations is an aircraft that is certified for a maximum seating capacity exceeding 38 or a maximum payload exceeding 4,200 kg.[9]

---

[7] Aircraft being operated with the experimental designation are included in the private category for recording and analysis purposes.

[8] CAR 206 (1) (c) and CAR 2 (7) (c).

[9] Civil Aviation Orders Section 82.0

- **Low capacity RPT**

  An aircraft with a maximum seating capacity of 38 or less, or a maximum payload of 4,200 kg or below [10] used for RPT operations is referred to as a low capacity aircraft.

General aviation

'General aviation' is defined as all non-scheduled civil flying activity other than RPT and sport aviation operations. The GA operations can be further divided into commercial and non-commercial operations. Commercial operations in GA include charter and aerial work. Aerial work includes, for example, flying training, agriculture operations, surveying, aerial photography, and aerial ambulance operations. Non-commercial refers to private and business operations.

- **Charter operations**

  Charter operations involve the carriage of cargo and/or passengers on non-scheduled operations by the aircraft operator, or the operators' employees, in trade or commerce, excluding regular public transport operations.

- **Aerial work**

  Aerial work operations comprise agricultural operations, flying training and other aerial work[11].

  a. **Agricultural operations -** operations involving the carriage and/or spreading of chemicals, seed, fertilizer or other substances for agricultural purposes. It includes operations for the purpose of pest and disease control. Agricultural operations are a component of aerial work, but are usually separated for reporting purposes.

  b. **Flying training -** flying under instruction for the issue or renewal of a license, rating, aircraft type endorsement or conversion training, including solo navigation exercises conducted as part of course of applied flying training. Flying training is a component of aerial work, but is usually separated for reporting purposes.

  c. **Other aerial work -** includes operations conducted for the purposes of aerial work other than 'flying training' and 'agricultural operations'. Operations classified as other aerial work include aerial operations involving surveying and photography, spotting, ambulance, stock mustering, search and rescue, towing (including glider, target and banner towing), advertising, cloud seeding, fire fighting, and coastal surveillance.

- **Business**

  Business flying is associated with a business or profession, but not directly for hire and reward.

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[10] Civil Aviation Orders Section 82.0.

[11] Due to the large proportion of aerial work operations associated with agricultural operations and flying training, these groups are separated for analysis. The remaining aerial work operations are referred to as 'other aerial work'.

- **Private**

  Private flying refers to flying for recreation or personal transport that is not associated with a business or profession. Test and ferry/positioning flying is not grouped under private flying. Such activity is allocated to the principle operation that is generally undertaken by the aircraft.

Sport aviation

Typically, the ATSB does not investigate and report on sport aviation accidents or incidents. For the purposes of this report, however, it was necessary to include data on sport aviation. This included sport aviation activities involving hang gliders, balloons, autogyros, gliders/sailplanes, ultralights and airships.

2.3 Accident and incident indicators

Accident and incident indicators have enabled the ATSB to examine the characteristics and safety trends associated with aviation within Australia. For example, the report *Aviation Safety Indicators – A report on safety indicators relating to Australian aviation* (ATSB, 2005), used accident rates to examine the number of fatal and non-fatal accidents for the GA sector from 1990 to 2003.

To identify safety and industry trends in aviation it is necessary to use some type of measure or indicator. The International Civil Aviation Organization (ICAO) definitions for an aircraft accident and an aircraft incident have been adopted by Australia and have been incorporated into ATSB investigative and data analysis processes. The definitions provided in Annex 13 to the Convention on International Civil Aviation (ICAO, 2001) are:

> **Accident** - an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which:
>
> a) a person is fatally or seriously injured as a result of:
>
> - being in the aircraft, or
> - direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or
> - direct exposure to jet blast,
>
> except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or
>
> b) the aircraft sustains damage or structural failure which:
>
> - adversely affects the structural strength, performance or flight characteristics of the aircraft, and
> - would normally require major repair or replacement of the affected component,
>
> except for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories; or for damage limited to propellers, wing tips, antennas, tires, brakes, fairings, small dents or puncture holes in the aircraft skin; or

c) the aircraft is missing or is completely inaccessible.

Note 1. For statistical uniformity only an injury resulting in death within thirty days of the date of the accident is classified as a fatal injury by ICAO.

Note 2. An aircraft is considered to be missing when the official search has been terminated and the wreckage has not been located.

Incident - an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.

2.4 Low-level flying legislation

The *Civil Aviation Regulations 1988* contains a number of regulations in relation to low-level flying. Regulation 141 states that 'CASA may authorise low flying … over a specified part of a flying training area for the purpose of flying training.' Regulation 157 details the basic low-level restriction of 1,000 feet over '… any city, town or populous area' or 500 feet over '… any other area …' Subregulation (4) of regulation 157 lists a number of exemptions to the 1,000 and 500 feet rule – most notably for aerial work. Regulation 172 deals with low-level flying associated with Visual Flight Rules (VFR) flights and regulation 178 deals with low-level flying associated with Instrument Flight Rules (IFR) flights.

In recognition of the risks associated with low-level flying, special training and endorsements are required before a pilot can legally conduct low-level flying operations. *Civil Aviation Orders* Parts 20, 29, 40, 82 and 95 contain details of permissions, exemptions and conditions in relation to low-level flying in Australia.

2.5 General aviation

Since all wire-strike fatal accidents occurred in GA operations, this report focuses predominately on GA. In 2004, there were 715 active commercial aircraft operators performing GA activities. Approximately 65 per cent of the operators were small businesses operating three or less aircraft (BTRE, 2005).

There are a number of aircraft types associated with GA. Typically, these are single-engine fixed-wing aircraft of around 5,700 kg maximum takeoff weight (MTOW) or less, and rotary-wing aircraft of 2,960 kg MTOW or less. Between 1994 and 2004, GA fixed-wing aircraft performed an average of 1.5 million flying hours annually, and rotary-wing aircraft performed 0.27 million flying hours annually.

In 2002, there were approximately 6,700 single-engine and 1,700 multi-engine fixed-wing aircraft operating in GA. Most of the aircraft were between 21 and 25 years old. In addition, there were approximately 900 single-engine and 80 multi-engine rotary-wing aircraft in use, mostly between 11 and 15 years old (BTRE, 2003).

The operator's decision to use a fixed-wing or rotary-wing aircraft is often determined by a number of factors, including, but not limited to, aircraft availability, purchase cost, operating and maintenance costs, manoeuvrability, range, nature of the intended task(s) and aircraft capability in relation to the terrain associated with proposed operations.

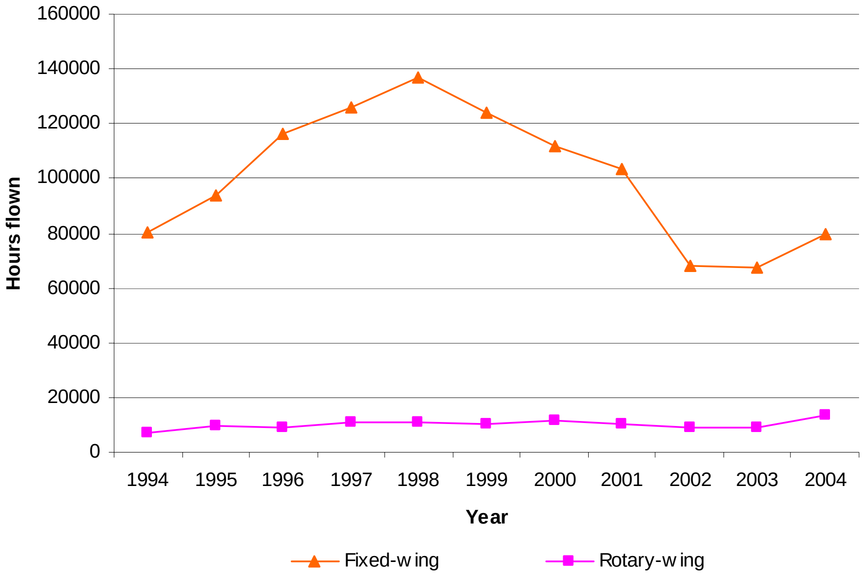
Aerial agriculture operations

To conduct aerial agriculture operations, a pilot must hold at least a commercial pilot licence and undertake extensive training to obtain an agricultural pilot rating issued by the Civil Aviation Safety Authority (CASA). Following the initial issue of an agricultural pilot rating, pilots are closely monitored by an approved agricultural pilot for a given number of flight hours. Furthermore, Civil Aviation Order 40.6 states that an agricultural pilot may not engage in aerial agricultural operations unless employed by the holder of an aerial work agricultural operator licence. In addition, all States require pilots to hold an agricultural chemical licence or rating (Aerial Agricultural Association of Australia, 2006).

Once qualified, pilots involved in aerial agriculture operations perform a variety of tasks. These include spraying for diseases and pests, sowing seed, and top dressing various crops such as cotton, rice and sugar cane (figures 4 to 7). The nature of agricultural flying is determined by environmental factors and the growing cycle. For example, the 2002 to 2003 drought reduced agricultural flying activity in Australia by over 35 per cent (BTRE, 2005).

Figure 8 shows the hours flown in fixed-wing and rotary-wing aircraft for aerial agriculture operations between 1994 and 2004. During this period, 92 per cent of all aerial agriculture operations were performed in fixed-wing aircraft. The remaining eight per cent were performed in rotary-wing aircraft.

Figure 8. Hours flown in aerial agriculture operations, 1994 to 2004



The average yearly flying hours for 1994 to 2001 was 110,600 hours. This number dropped to around 70,000 hours during the drought of 2002 and 2003. A slight recovery was experienced in hours flown for both fixed-wing and rotary-wing aircraft in 2004, to just over 93,000 hours in total.

Figure 4 to 7. Examples of aerial agriculture operations in Australia

Photos courtesy of Antony Annan

Table 1 lists the number of aircraft, hours flown by aircraft type, aircraft manufacturer, and average hours flown per aircraft type for aerial agriculture operations in 2002. This information provides an indication of the major types of aircraft used in aerial agriculture operations. The majority of hours flown in fixed-wing aircraft were carried out in the Air Tractor series aircraft (32 per cent) and the majority of work carried out in rotary-wing aircraft was performed in Bell series helicopters (42 per cent).

Table 1. Number of aircraft, hours flown, average hours flown by aircraft type and manufacturer for aerial agriculture operations, 2002

Aircraft type/manufacturer	Number of aircraft	Hours flown	Average hour flown	Per cent of hours flown
Fixed-wing – single-engine				
Air Parts	17	4,782	281.3	7.5
Air Tractor	79	20,252	256.4	32.0
Ayres	35	7,554	215.8	11.9
Cessna	63	8,855	140.6	14.0
Gippsland	9	2,778	308.7	4.4
Grumman	11	1,806	164.2	2.9
PZL	11	2,338	212.5	3.7
Piper	64	10,566	165.1	16.7
Transavia	9	1,608	178.7	2.5
Other	16	2,812	175.8	4.4
Total fixed-wing single-engine	*314*	*63,351*	*201.8*	*89.5*
Rotary-wing – single-engine				
Bell	17	3,107	182.8	41.8
Hiller	6	1,460	243.3	19.6
Hughes/Schweizer	7	944	134.9	12.7
Robinson	12	1,010	84.2	13.6
Other	7	910	130.0	12.2
Total rotary-wing single-engine	*49*	*7,431*	*151.7*	*10.5*
Total number of aircraft used in agriculture operations	***363***	***70,782***	***195.0***	***100.0***

Source: BTRE (2003)

2.6 Wire-strike hazards

Wire strikes generally occur when an aircraft is operating in close proximity to the ground, including the landing and take-off phases of flight. However, on occasion, wire strikes have occurred over water where a wire is strung between two high points. On 7 February 2004, a Piper PA-28R-200 aircraft struck powerlines while conducting a private sightseeing flight over Lake Eildon in Victoria. The aircraft struck the powerlines at about the lowest point of the span, which was approximately 122 feet above the surface of the lake (ATSB Report: 200400437).

Low flying is hazardous because of the aircraft's close proximity to obstructions such as trees, powerlines, buildings and radio towers. Colliding with obstructions such as these can cause significant damage to an aircraft, resulting in loss of control and subsequent impact with the ground or water. Impact forces will likely involve further aircraft damage and possibly injury or death to aircraft occupants.

In addition to obstructions, there are several other factors that may elevate the risk of low-level flying. Of significance is the relatively short distance between the aircraft and the ground or water, which according to Freeman (1995) reduces and in some cases removes the options for a pilot to manoeuvre to avoid a collision or recover from a loss of control.

Other factors that may elevate the level of risk include wind velocity (direction and speed), the effect of terrain on the wind and any consequent turbulence, maintaining lift if speed is reduced, maintaining height (particularly over hilly terrain), aircraft inertia, manoeuvring space (especially for turning), and avoiding other air traffic (including birds).

Figure 9 shows the devastating consequences of an accident involving a Bell 47G-3B-1 Soloy[12] helicopter near Wodonga in Victoria that occurred on 19 June 2004. The pilot was the sole occupant and was fatally injured. The operator of the aircraft was contracted to spray herbicide on a property in Victoria, where it collided with powerlines 12 km west of Wodonga. The powerlines '… consisted of two parallel three-strand lightweight high-tensile steel cables, each of 2.75 mm diameter.' A photo of the damaged wires is presented in figure 10. The powerlines were located on the north-eastern side of a ridgeline, strung across a direct track from the spray area to the replenishment truck (figure 11). The full investigation report is available on the ATSB website (ATSB Report: 200402669).

Figure 9. Bell 47G-3B-1 Soloy helicopter after striking powerlines near Wodonga on 19 June 2004

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[12] The designation 'Soloy' indicates that the helicopter had been modified and fitted with a turboshaft engine.

Figure 10. Damaged powerlines after being struck by the Bell 47G-3B-1 Soloy helicopter

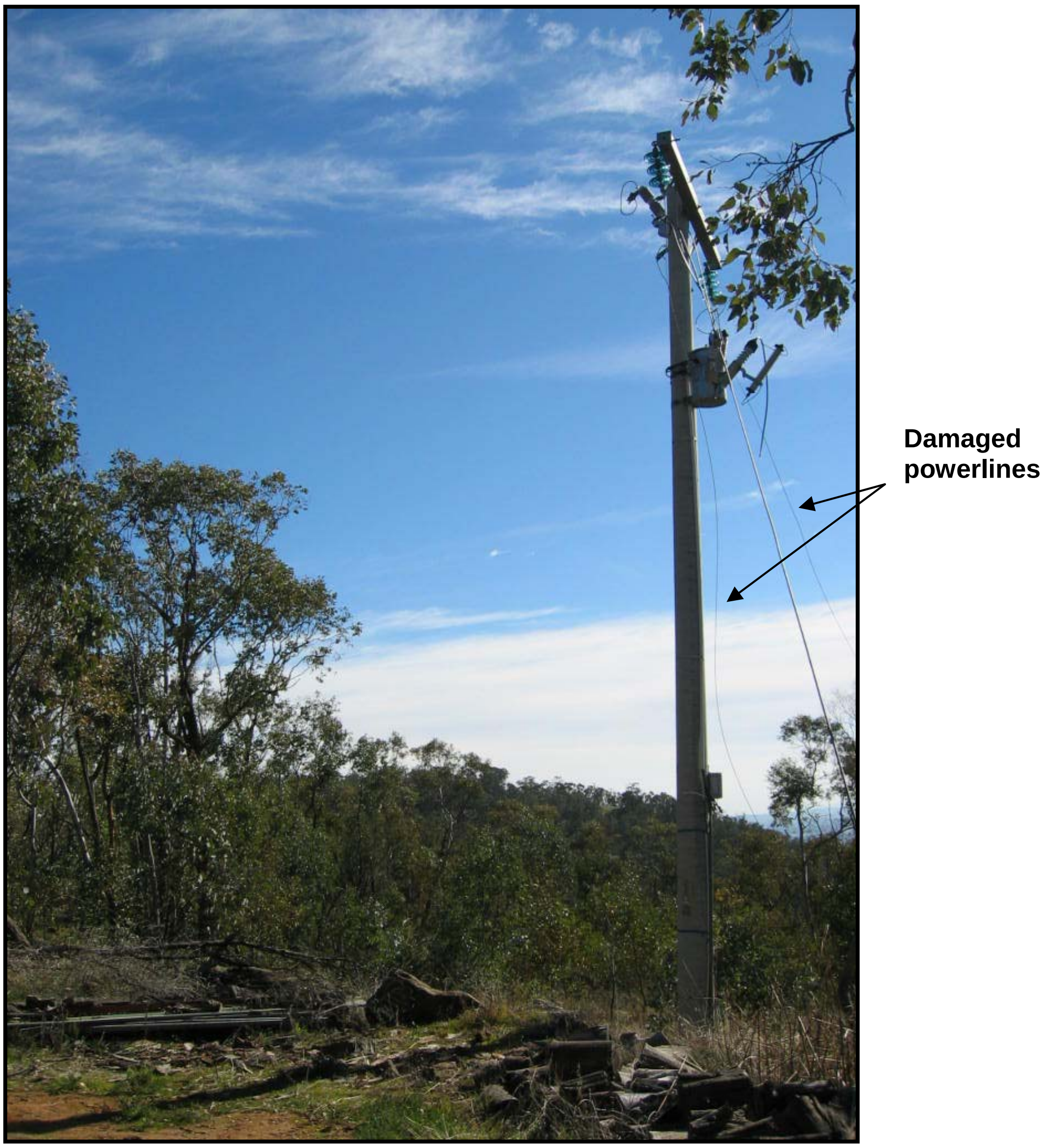
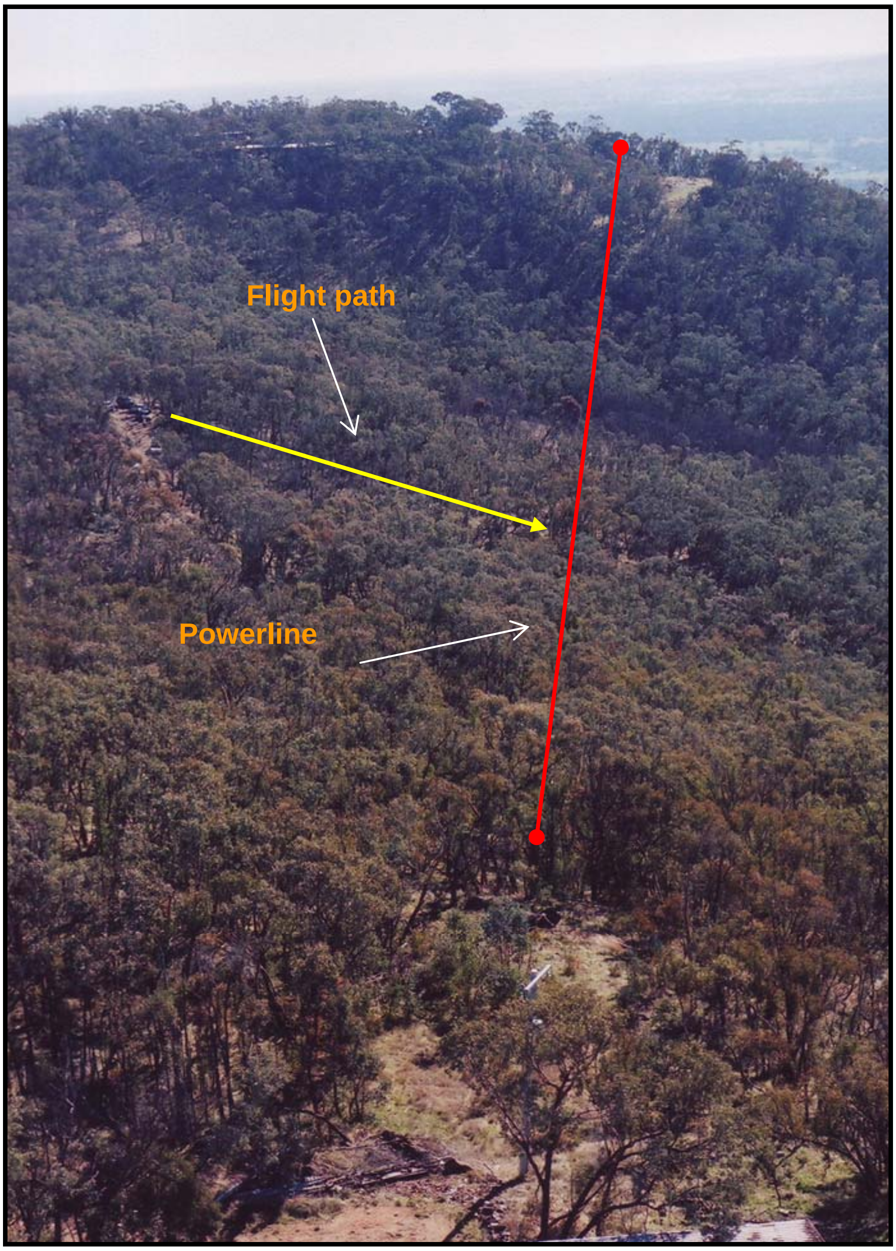


Figure 11. Aerial view of the powerline and the approximate track of the Bell 47G-3B-1 Soloy helicopter



2.7 Powerlines

2.7.1 Characteristics of powerlines

Powerlines have various configurations that range from multiple clusters of high voltage wires carried on large lattice type towers, to a single wire earth return (SWER) system. The former are high tensile heavy gauge wires that may be found at heights in excess of 100 feet AGL. Figures 12 to 17 show examples of various powerline arrangements in New South Wales.

Figure 12 to 17. Examples of powerline arrangements in New South Wales

The SWER system is characterised by only one wire. It can be strung in spans of up to 400 metres. The system is particularly hazardous to pilots, as both the wire and the supporting poles may be difficult to distinguish from the background environment. Furthermore, these wires are often found across the approach path to a country paddock or airstrip (Freeman, 1995).

Guy wires[13] can also be difficult for pilots to see, even when the location of the wire is known. As shown in figure 18, guy wires are generally located at either the end of a wire run or on a bend in the run to counterbalance the pull of the wires.

Figure 18. Example of a guy wire

2.7.2 Identifying powerlines

A number of factors associated with powerlines, such as the number of wires, the height of the wires, and the direction of the wire run, can determine whether or not a pilot sees a wire. Additionally, the material used to manufacture the wire can impact visibility, for example, copper wire oxidises to blue/grey – a difficult colour to distinguish against Australian eucalypts. Aluminium might offer a better contrast as it oxidises to silver. Single powerlines are possibly the greatest hazard, as they can be extremely difficult to detect from the air and can be encountered in the most unexpected places in rural areas (RAAF, 1997). Other factors restricting visibility include the position of the sun, changing light conditions, background camouflage, the obscuring effects of terrain, and poor weather. A more obvious factor is a dirty windscreen.

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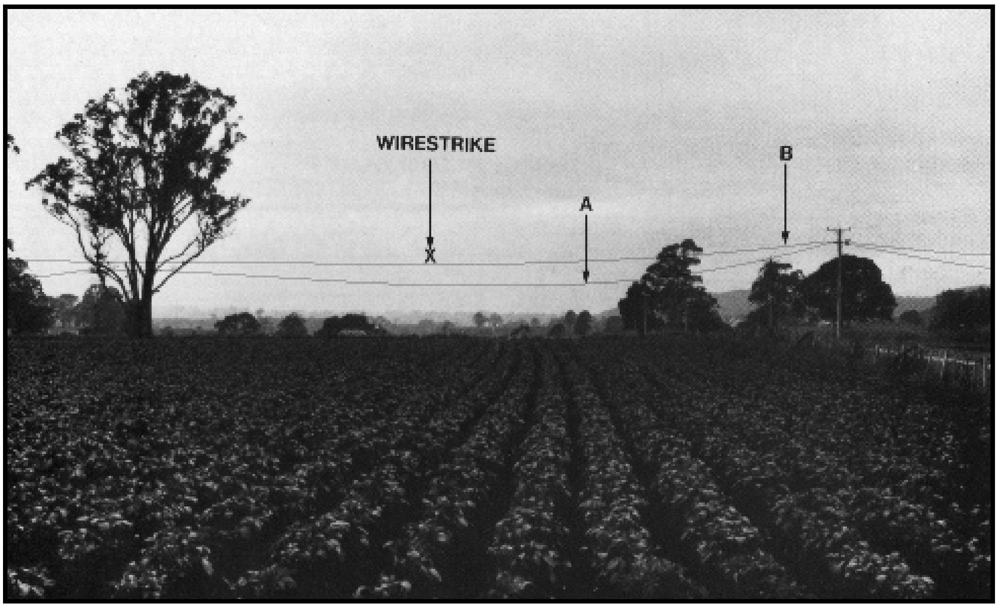
[13] A wire used to secure a power pole in position against the pull of the wire run.

Even if a wire can be seen, a pilot's ability to judge its position accurately may be reduced by a number of factors. For example, ambient temperature can change the location of the wire by causing the wire to sag or tighten, and windy conditions may cause sagging wires to be blown about (Harris, 2003). In addition, the ability to judge distance correctly can be distorted by optical illusions. As illustrated in figure 19, higher wires appear to be further away when viewed in combination with lower wires. This effect only resolves at distances less than 100 metres, thereby leaving the pilot little time to react (Freeman, 1995).

Figure 19. Focussing on high and low wires together can create the illusion that the higher wire (B) is further away than the lower wire (A)



Source: BASI (1985)

The ability to identify the presence of powerlines can be facilitated by objects and landmarks on the ground. Buildings such as houses and sheds are likely to have power connected through above-ground wires. Roads may also provide a convenient path for powerlines. Furthermore, power poles may offer clues as to wire direction and height. By identifying at least two poles, a pilot may be able to gauge the path of the wire. Insulators attached to the poles run in the same direction as the wire and may also assist in identifying the number of wires and their direction. The orientation of the insulators could indicate whether the wire continues in the same direction or turns a corner. The presence of bucked arms[14] could provide evidence of additional wires or a new wire run.

Although poles provide pilots with one of the most reliable indicators of the presence of wires, the poles themselves are not always easy to see. Wooden poles, in particular, can be easily camouflaged by the landscape or hidden by foliage and trees (figure 20). Since poles are typically used by pilots to alert them to the presence of a wire run, the concealment of poles may increase the risk of a wire-strike.

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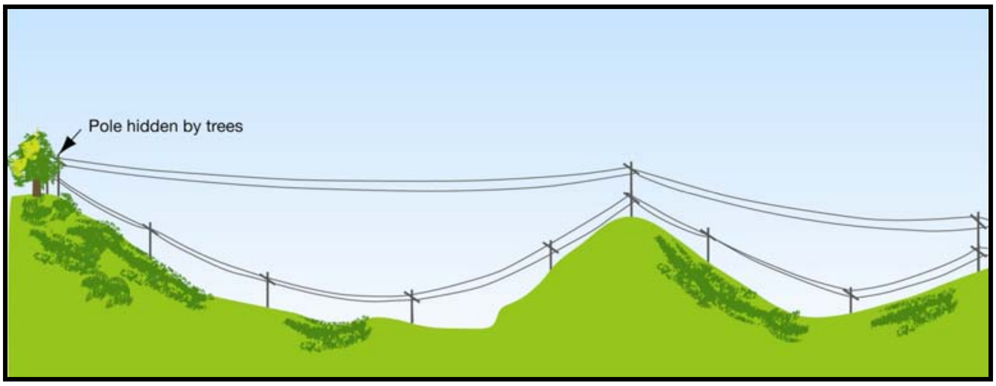
[14] Bucked arms are the cross members on a powerline structure that support additional wire runs.

Figure 20. Wire hazard caused by the pole being hidden by trees



Source: Aerial Agricultural Association of Australia (2004)

Another factor hindering a pilot’s ability to detect poles is the physiological limitations of the eye. When looking straight ahead, each eye has a normal field of vision of about 120 degrees vertically and about 200 degrees horizontally (Miller & Tredici, 1991). However, the field of vision that enables clear and detailed perception of objects is far narrower. According to Freeman (1995), for poles to be visible to the pilot, they must be positioned within a 70 degree angle. Problems arise when the wire span is long and requires poles to be placed several hundred metres apart. When this occurs, the pilot’s ability to focus on the pole and recognise a potential wire hazard is decreased.

2.8 Pilot distraction

According to the *Aerial Application Pilots Manual*, without some positive reminder of the presence of the wire, it is easy for a pilot to forget about it. This is especially true if a distraction occurs at the critical moment when the pilot should be thinking about initiating the pull-up (Aerial Agricultural Association of Australia, 2004).

Figure 21 shows the devastating impact of a wire-strike on a Piper PA-25-235 aircraft when it struck powerlines during a pull-up from the first of three spray runs. The accident occurred 23 km North West of Amberley in Queensland resulting in serious injuries to the pilot, the sole occupant. Although the pilot was aware of the powerlines, having sprayed in the area before, his attention had been diverted elsewhere (ATSB Report: 198200054).

Figure 21. Aircraft after striking a high tension powerline during a pull-up manoeuvre

There are a number of factors that cause pilot distraction. These include deteriorating weather conditions, personal stress, objects on the ground, radio calls, equipment malfunctions and passengers. A recent aviation research investigation report published by the ATSB suggests that pilot distractions can be broadly classified into four different groups (ATSB, 2006b) including:

- **Visual distraction –** looking at the spraying area, or particularly eye-catching scenery
- **Auditory distraction** – radio or mobile phone
- **Biomechanical (physical) distraction** – manipulating a control
- **Cognitive distraction** – being 'lost in thought' or engrossed in the task

Each of these types of distraction, either singularly or in combination, can take a pilot's attention away from the task of flying. The adverse effect of an auditory distraction is demonstrated in the following excerpt from an ATSB investigation. The distraction, caused by a radio broadcast from another spraying aircraft, diverted the pilot's attention away from the task of agricultural spraying. The aircraft struck powerlines and the accident resulted in serious injury to the pilot and significant damage to the aircraft.

> During agricultural spraying operations, as the pilot was descending to commence another swath run, the aircraft's main landing gear struck a powerline and it dived vertically into the cotton crop. The impact destroyed the entire forward section of the fuselage, spilling the complete load of chemical. The pilot was seriously injured and remained trapped in the wreckage for a considerable time while emergency personnel established the toxic risk. During this time the pilot was attended to by the property owner and ambulance officers. The operator later reported that the support pole for the wire was hidden by a shed and that the pilot had been distracted by a radio call from another spraying aircraft operating nearby. (ATSB Occurrence No.: 200100476)

2.9 Wire-strike prevention

2.9.1 Situational awareness

Risk mitigation strategies associated with low-level flying rely heavily on the level of situational awareness maintained by the pilot. Strategies used to establish and maintain adequate situational awareness include reading the physical structure indicators (ie orientation of insulators, presence of bucked arms and sighting two or more poles), self discipline, pre-flight briefing, pre-flight reconnaissance and observation, memory and awareness, appropriate flying techniques, maintenance of a good visual scan and consideration of weather factors (BASI, 1991). Additionally, pilots need to guard against deviating from low-flying routes and areas previously checked for wires.

To assist pilots in the detection of wires, a number of non-human strategies have been developed. These include wire markers and wire detection systems. Additionally, wire-strike protection systems could, if fitted, provide a defence against the consequences of a wire-strike.

2.9.2 Wire markers

The requirements for the mapping and marking of power cables and their supporting structures are published in the following Australian Standards:

> **AS 3891.1 - 1991 Air Navigation** - cables and their supporting structures - mapping and marking. Part 1: Permanent marking of overhead cables and their supporting structures. This standard, approved on 18 February 1991 and published on 15 April 1991, '...specifies the requirements for aircraft warning markers for use on overhead cables and their supporting structures' (Standards Australia, 1991).
>
> **AS 3891.2 - 1992 Air Navigation** - cables and their supporting structures - mapping and marking. Part 2: Marking of overhead cables for low-level flying. This standard, approved on 1 September 1992 and published on 14 December 1992, '...specifies requirements for permanent and temporary marking of overhead cables and their supporting structures for visual warnings to pilots of aircraft involved in low-level flying operations'. Pilots are required to '...be satisfied as to the need for and effectiveness of markers prior to commencing low-level operations' (Standards Australia, 1992)

Since the introduction of the current standards, the aviation industry has experienced many changes including the increasing demand for aerial fire-fighting services and the use of global positioning systems to assist aircraft engaged in aerial agricultural operations. As a result, Standards Australia is in the process of revising the standards for the marking of overhead cables for the safety of aircraft. The review is expected to take into consideration the minimum length of span to be marked, the use of cost effective and temporary markers, the use of geographic information systems and the size of cables requiring marking (Energy Networks Association, 2006).

In general, there is no requirement for the marking of cables with a height above terrain or obstacles of less than 90 metres. The standards assume pilot familiarity with the hazards in the low-level operating area, and that a visual reminder is only required of the exact location of the cables. Additionally, approval by the cable owner is required for the installation of above-ground wire markers.

Wire markers can be white, yellow, red or orange, and may be spheres, warning lights, marker panels or over-crossing markers in accordance with Standards Australia. The markers shown in figures 22 and 23 are red spheres.

Figure 22. Example of a marker mounted on a powerline

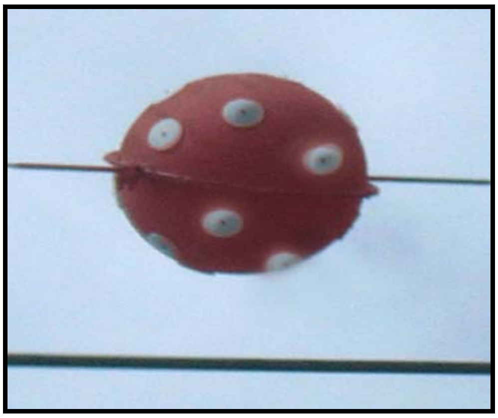


Figure 23. Example of wire markers mounted on a multi-strand powerline

More recently, Country Energy (New South Wales) has developed a cost effective powerline 'flag marker' to be used in areas such as crop spraying and harvesting, temporary or non-licensed aircraft landing areas, temporary air bases for fire fighting operations and external construction sites. As shown in figures 24 and 25, the marker is a mud flap shaped marker with a green retro reflector. The marker is designed to clip onto a range of conductors to increase visibility (A. Burman, personal communication, June 5, 2006).

Figure 24. Example of a 'flag marker' used for aerial operations

Source: Country Energy

Figure 25. Example of a 'flag marker' used on overhead powerlines

Source: Country Energy

The supporting structures of powerlines may also be illuminated, but this only provides pilots with a visual que at night. One system currently installed in Norway and under trial in North America is a low-powered radar system mounted on or near powerline support structures that detects aircraft within a specified distance of powerlines and the support structure. Once detected, the system activates strobe lights and, if the aircraft continues on its original track, the system transmits a warning on locally-used very high frequency (VHF) radios.

2.9.3 On-board detection systems

A number of on-board detection systems have been developed to warn pilots of their proximity to wires. These include:

- A system that detects the electromagnetic field generated by powerlines. However, this system does not identify the location of the wire and will only activate if the wire is live.
- A system that utilises lasers to scan the environment ahead of the aircraft for wires and other flight obstacles.
- A system that uses a database of terrain and wire location information to warn pilots of rising terrain and obstacles that are more than 100 feet above the ground.

Alerts for on-board detection systems can be in the form of an aural alert, which may also give an indication of the proximity of the wire, and/or a visual alert, which may be an illuminated warning light or an indication on a map display.

2.9.4 Wire-strike protection systems

As a last resort, when pilot situational awareness and on-board systems fail to detect a wire in sufficient time to avoid contact, a passive wire-strike protection system (WSPS) may protect the aircraft from the consequences of a wire-strike. These are designed to cut or deflect wires away from an aircraft. The types of WSPS vary depending on whether the aircraft is fixed-wing or rotary-wing. They have proven to be an effective safeguard by extensive testing and over two decades of use by both military and non-military operators' worldwide (Jackson, Boitnott, Fasanella, Jones & Lyle, 2004; RAAF, 1997). However, to enable the WSPS to operate effectively, the wire must contact the cutter at an appropriate angle and the aircraft must also have adequate forward speed. This combination of circumstances may not always be present during low-level aerial operations.

WSPS for fixed-wing aircraft are designed to cut wires that could pass under the aircraft, in order to prevent the wires from coming into contact with the landing gear, or pass over the aircraft, possibly contacting the tail section. Serrated deflection wires may also be fitted from the cabin to the tail section, with the purpose of cutting the wire or lifting it over the tail section.

Fixed-wing aircraft used in aerial agriculture operations have had WSPS fitted as standard equipment for several years. Fixed-wing aircraft used for other purposes rarely carry WSPS as fitment often requires reinforcing parts of the aircraft and may cost several thousand dollars. In general, they are not fitted unless it is expected that the aircraft will spend many hours in low-level flight.

On rotary-wing aircraft, WSPS are generally fitted to larger, heavier and faster models. Smaller aircraft, including Robinson series helicopters, generally have no structural hard points to fit a WSPS and are generally too light and, in many instances, travel too slowly for WSPS to be effective.

For larger helicopters, WSPS typically consists of an upper cutter/deflector, a windshield deflector and a lower cutter/deflector. The cutters are equipped with high tensile steel cutting blades to sever the wire, reducing the possibility of wires entering the cockpit area and damaging flight controls and/or becoming entangled in the landing gear or rotor assemblies. There are also explosive WSPS that cut the wire when activated, although these are typically only found on military rotary-wing aircraft.

3 METHOD

3.1 Data sources

Information for this report was provided by the Bureau of Transport and Regional Economics (BTRE), ATSB transport safety investigators, aerial agriculture operation specialists and other aviation experts. The data analysed was extracted from the ATSB's aviation accident and incident database.

3.2 Aviation accident and incident database

In accordance with the *Transport Safety Investigation Act 2003*, all accidents and incidents related to flight safety in Australia or by Australian operators overseas must be reported to the ATSB. All reported occurrences that meet defined criteria are then entered into the ATSB database. The reliability of the database is therefore dependent on individual compliance with the compulsory reporting requirements. Despite these requirements, anecdotal evidence suggests under reporting of accidents and incidents persists, especially where aircraft and property damage is minimal. Although an estimate of the degree of under reporting is difficult to verify, it is likely that the data contained in this report are a conservative representation of actual numbers of wire strikes.

3.3 Data analysis

The ATSB accident and incident database was searched to identify occurrences that involved an aircraft striking a wire between 1994 and 2004. Of these occurrences, 11 were identified where another critical event such as engine failure or simulated engine failure, fuel starvation, and in one case main rotor failure, occurred prior to the wire-strike event. These occurrences were removed from the dataset in order to focus on accidents and incidents where a wire strike was the primary event.

The remaining accidents and incidents were then categorised by the type of operation being conducted at the time of the wire-strike. During the reporting period, 215 reported wire-strike accidents and incidents occurred during GA operations and 21 occurred during sport aviation operations. There were no wire-strike accidents or incidents recorded during RPT operations. The 21 sport aviation occurrences were removed from the dataset, thereby restricting the dataset to GA.

Of the 215 GA accidents and incidents, 98 were classified as incidents. Anecdotal evidence from aviation industry bodies suggests that incidents involving a wire-strike, particularly when there are no serious consequences, are significantly under-reported to the ATSB. Since any analyses involving incident data would be misleading, all incidents involving wire-strikes were excluded from further analyses. The remaining 117 occurrences were accidents involving a wire-strike as a primary event, and are hereafter referred to as 'wire-strike accidents'.

Tests of statistical significance were not undertaken due to the low number of observations, the low volume of occurrences in some categories and marked seasonal effects, particularly in aerial agriculture operations. In cases where numbers were sufficient for interpretation, trends were not apparent and analysis was not warranted.

4 RESULTS

4.1 Trends in wire-strike accidents and incidents

Accidents and incidents

In total, there were 215 GA accidents and incidents reported to the ATSB between 1994 and 2004 where the primary event was a wire strike. Of the number of accidents reported, 34 involved fatalities.

Table 2 shows the number of accidents and incidents annually ranged from 33 in 1998 to eight in 2002, with an average of 19.5 per year. The number of wire-strike accidents ranged from 16 in 1997 and 1998 to two in 2003, with an average of 11 accidents per year.

Table 2. Accidents and incidents involving a wire-strike, 1994 to 2004

Year	Accidents	Fatal accidents	Incidents	Accidents and incidents
1994	14	4	5	19
1995	14	5	7	21
1996	13	4	7	20
1997	16	4	7	23
1998	16	5	17	33
1999	11	3	10	21
2000	9	2	12	21
2001	10	3	10	20
2002	3	1	5	8
2003	2	0	10	12
2004	9	3	8	17
Total	***117***	***34***	***98***	***215***

Accident rate for GA

A 3-year prior moving average (PMA)[15] was calculated by combining the data for a particular year with the previous 2 years and calculating the average. This calculation evened out random variation in the data, making trends more apparent. Figure 24 shows that the PMA for the rate of wire-strike accidents per 100,000 hours flown declined from 1998, indicating a downward trend. From 2003 to 2004, the PMA was considerably flatter.

Figure 26 shows that the rate of wire-strike accidents per 100,000 GA hours flown ranged from around 0.9 in 1997 and 1998 to 0.1 in 2003. There were 0.5 wire-strike accidents per 100,000 hours flown in 2004, indicating an increase in accidents compared with the previous year. It is possible that the environment, and in particular drought conditions, influenced the accident rate over the 1994 to 2000 period.

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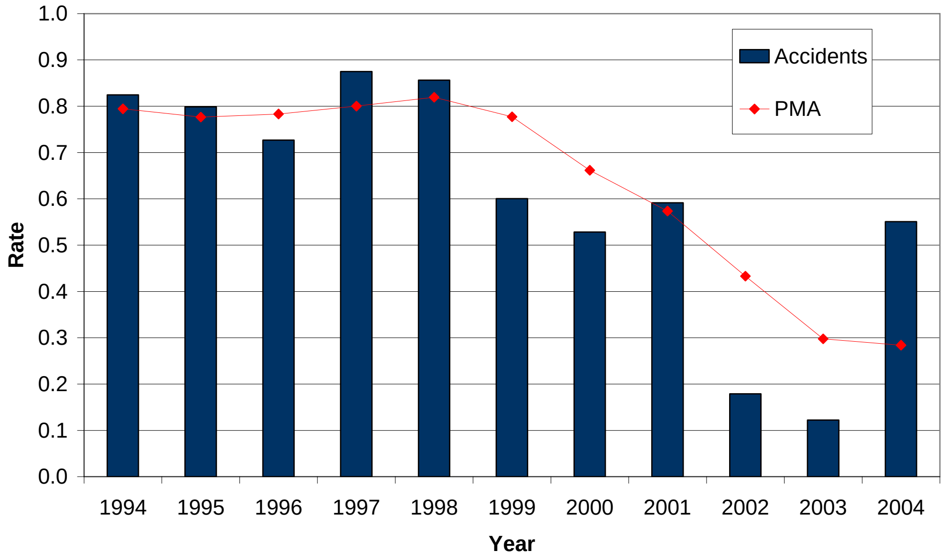
[15] PMA – used to smooth the graphical representation of data from a small number of occurrences when the time period spans several years.

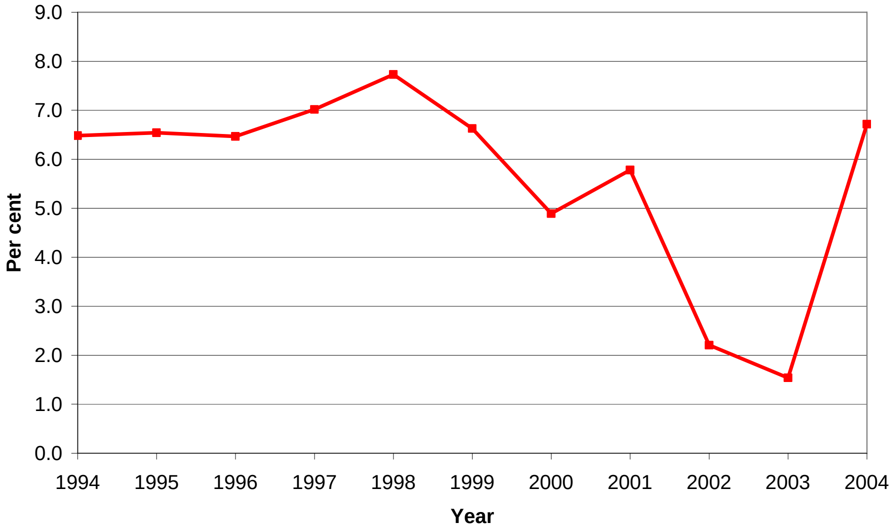
Figure 26. Wire-strike accidents for GA operations per 100,000 hours flown, 1994 to 2004



Wire-strike accidents compared with all GA accidents

Figure 27 shows that between 1994 and 2004 wire-strike accidents ranged between 1.5 per cent in 2003 to 7.7 per cent in 1998, with an average of 5.5 per cent each year over the period. There was a significant reduction in the proportion of GA wire-strike accidents in 2002 and 2003, to 2.2 per cent and 1.5 per cent respectively. Wire-strike accidents accounted for 6.7 per cent of all GA accidents in 2004, the highest proportion since 1998.

Figure 27. Wire-strike accidents as a proportion of all GA accidents, 1994 to 2004



Occupant injuries

Table 3 shows there were 240 people involved in the 117 wire-strike accidents that occurred between 1994 and 2004, just under half of whom received some degree of injury. This number included 45 people (19 per cent) with fatal injuries, 21 (9 per cent) with serious injuries, and 44 (18 per cent) with minor injuries. There were 130 (54 per cent) people who were not injured.

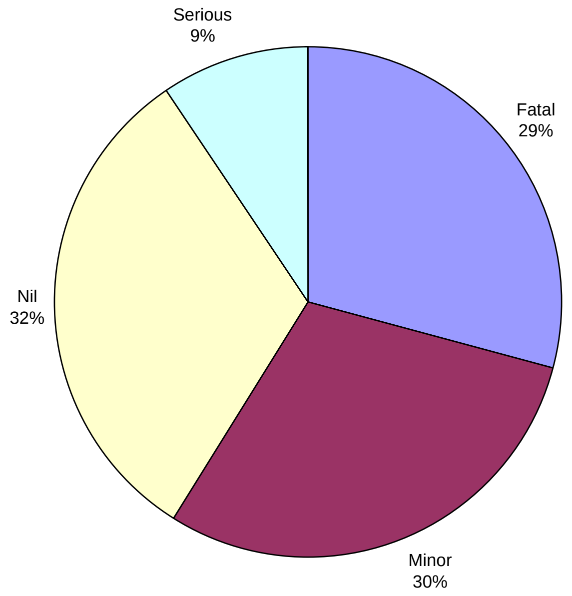
The numbers were too low to assess any emerging trends in levels of injury over time. Notably, no one was seriously injured or killed in 2003. In contrast, during 2004 seven people were fatally injured, the highest since 1998, and one person was seriously injured.

Table 3. People involved in wire-strike accidents by level of injury, 1994 to 2004

Year	Fatal	Serious	Minor	Not injured	Total
1994	4	2	5	15	26
1995	7	2	6	9	24
1996	4	3	2	15	24
1997	5	1	2	22	30
1998	7	3	5	18	33
1999	4	3	3	10	20
2000	2	2	1	19	24
2001	4	3	9	6	22
2002	1	1	2	0	4
2003	0	0	1	10	11
2004	7	1	8	6	22
Total	***45***	***21***	***44***	***130***	***240***

Figure 28 shows the proportion of wire-strike accidents by the maximum level of injury received in relation to the accident. Nearly one third (29 per cent) of wire-strike accidents resulted in at least one fatal injury, 9 per cent resulted in at least one serious injury, and 30 per cent resulted in at least one minor injury. There were no injuries for 32 per cent of wire-strike accidents.

Figure 28. Percentage of wire-strike accidents by maximum level of injury, 1994 to 2004



4.2 Pilot awareness of the wire

Of the 117 accidents involving a wire-strike between 1994 and 2004, the pilot's prior knowledge of the wire was established in 81 cases. Table 4 shows that 63 per cent of pilots were aware of the wire before it was struck.

Table 4. Wire-strike accidents and pilot's awareness of the wire before the accident, 1994 to 2004

	Number	Per cent
Aware	51	63
Unaware	30	37
Total	***81***	***100***

4.3 Phase of flight

Table 5 shows that 80 per cent of wire-strike accidents occurred during the manoeuvring phase of flight. This phase included turning manoeuvres during agricultural spraying and other low-level aerial work.

Table 5. Wire-strike accidents by phase of flight, 1994 to 2004

	Number	Per cent
Manoeuvring	94	80
Approach	8	7
En-route	6	5
Landing	2	2
Take-off	5	4
Taxiing	2	2
Total	***117***	***100***

4.4 Type of operation

Table 6 shows that 64 per cent of the 117 wire-strike accidents between 1994 and 2004 occurred within the aerial agriculture operations category (75 accidents). The other aerial work category recorded 22 accidents (19 per cent) and the private and business flying category recorded 17 accidents (15 per cent). The charter category recorded one accident, while the flying training category recorded two.

Table 6. Wire-strike accidents by ATSB statistical categories, 1994 to 2004

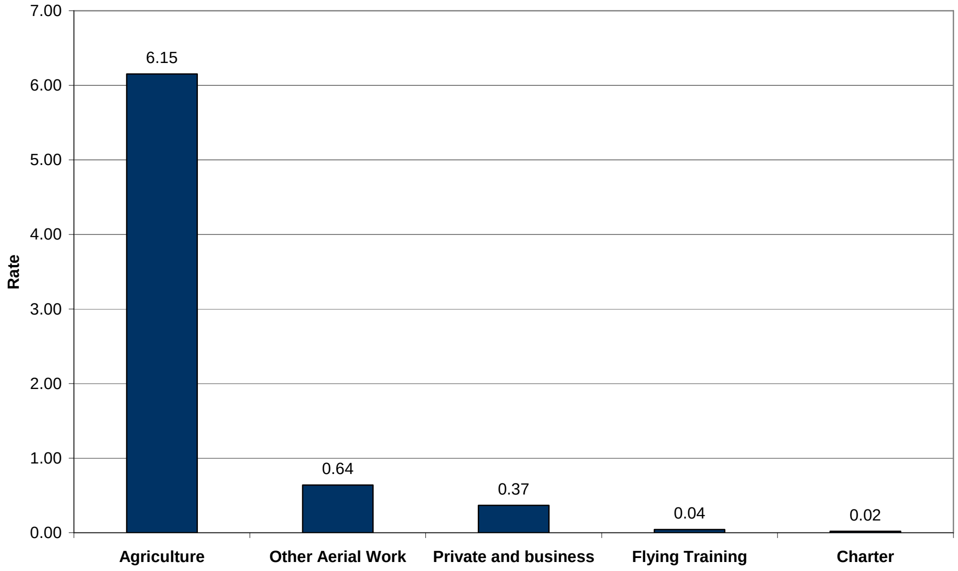
Year	Charter	Agriculture	Flying training	Other aerial work	Private and business	Total
1994	0	9	1	3	1	14
1995	0	8	0	3	3	14
1996	0	10	0	3	0	13
1997	1	8	0	3	4	16
1998	0	12	1	1	2	16
1999	0	8	0	0	3	11
2000	0	6	0	2	1	9
2001	0	7	0	2	1	10
2002	0	2	0	1	0	3
2003	0	1	0	0	1	2
2004	0	4	0	4	1	9
Total	***1***	***75***	***2***	***22***	***17***	***117***

It is worth noting that there was a significant reduction in the number of hours flown by aircraft involved in aerial agriculture operations during 2002 and 2003. This is likely to be associated with drought conditions during these years. It may also explain the significant decline in wire-strike accidents during 2002 and 2003 and the increase in accidents in 2004 as drought conditions eased.

In addition, there was a relatively low number of wire-strike accidents involving other aerial work category aircraft (eg low-level agricultural pest survey, feral animal control and mustering) in 2002 and 2003. Again, this may be related to drought conditions.

Figure 29 presents the rate of wire-strikes by flying category per 100,000 hours flown. Aerial agriculture operations experienced a rate of 6.15 wire-strike accidents per 100,000 hours flown. This was almost ten times the rate of accidents for the other aerial work category (0.64) and almost 17 times the rate for private and business flying (0.37). Furthermore, aircraft operating within the flying training category recorded 0.04 wire-strike accidents per 100,000 hours flown and the charter category recorded 0.02.

Figure 29. Wire-strike accidents for GA operations per 100,000 hours flown, 1994 to 2004



The large discrepancy between aerial agriculture operations and other flying categories is likely to be a reflection of the considerable amount of low-level flying conducted during aerial agriculture operations compared with other flying categories. Legitimate low-level flying also makes up a component of tasks completed by the other aerial work category operators and may explain the higher rate compared with the other categories. There was no data available to compare low-level flying risk exposure within each statistical category.

4.4.1 Aerial agriculture operations

The relative frequency of accidents involving wire-strikes within aerial agriculture operations justifies further in-depth analyses. Figure 30 shows the rate of wire-strike accidents per 100,000 hours flown for the aerial agriculture operations category. The yearly accident rate ranged from 10.4 in 1994 to 1.3 in 2003. Rates for 2002 and 2003 showed notable declines, but figures appeared to return to the previous level in 2004 with a rate of 4.3. It is not possible to ascertain from the data available the reasons for the decreased accident rate in 2002 and 2003, however, the reduction in rates coincided with drought conditions and a decrease in agricultural flying[16].

Figure 30. Wire-strike accidents for aerial agriculture operations per 100,000 hours flown, 1994 to 2004

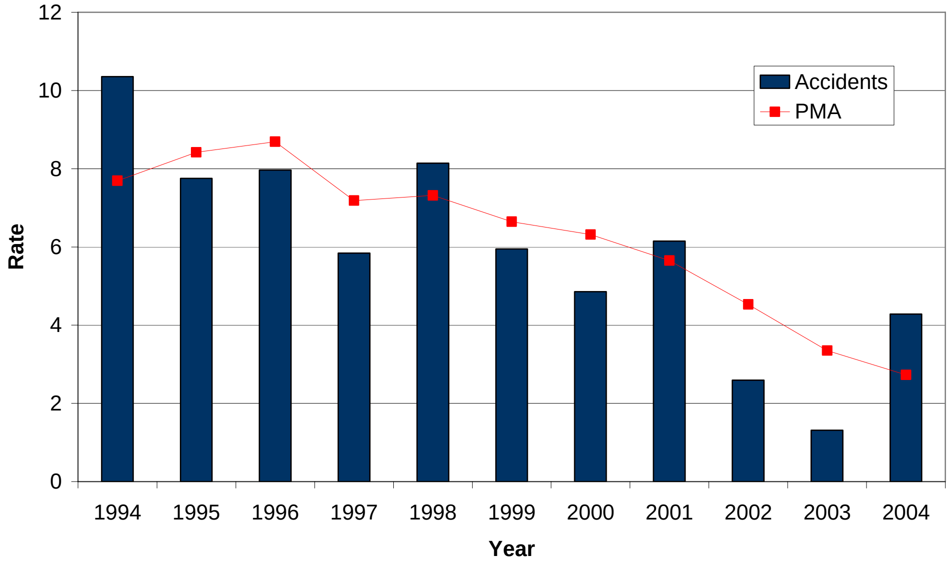


Figure 31 shows the average number of wire-strike accidents reported to the ATSB per month over the period 1994 to 2004. It also depicts a seasonal increase from September through to February, most likely corresponding to an increase of agricultural activity over the period.

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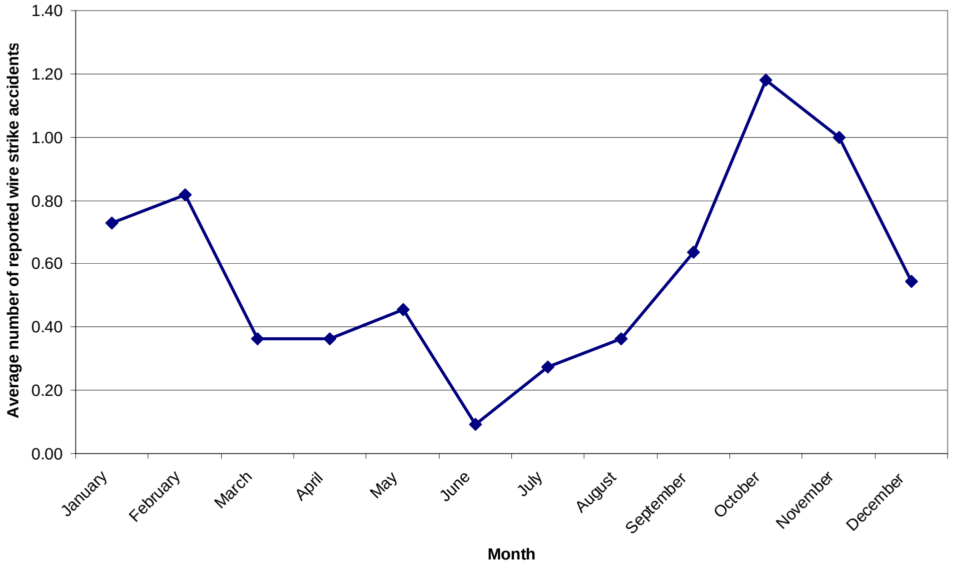
[16] Caution should be exercised when interpreting these results, since the number of accidents per year was relatively small and a single accident could influence the rate considerably.

Figure 31. Average number of wire-strike accidents reported per month for aerial agriculture operations, 1994 to 2004



Of the 75 wire-strike accidents between 1994 and 2004 involving aerial agriculture aircraft, the pilot's prior knowledge, or lack of knowledge, of the wire was established in 56 cases. Table 7 shows that 71 per cent of pilots were aware of the wire before they struck it.

Table 7. Wire-strike accidents involving aerial agriculture aircraft and pilots' awareness of the wire before the accident, 1994 to 2004

	Number	Per cent
Aware	40	71
Unaware	16	29
Total	***56***	***100***

4.5 Fixed-wing and rotary-wing accidents

Table 8 shows that, between 1994 and 2004, 56 per cent of reported wire-strike accidents involved fixed-wing aircraft and 44 per cent involved rotary-wing aircraft.

Table 8. Wire-strike accidents, 1994 to 2004

Year	Fixed-wing	Rotary-wing	Total
1994	6	8	14
1995	8	6	14
1996	6	7	13
1997	12	4	16
1998	10	6	16
1999	8	3	11
2000	5	4	9
2001	7	3	10
2002	2	1	3
2003	0	2	2
2004	2	7	9
Total	***66***	***51***	***117***

Table 9 shows that of the three main statistical categories, 67 per cent of wire-strike accidents involving agricultural aircraft occurred in fixed-wing aircraft and 33 per cent occurred in rotary-wing aircraft. For other aerial work operations, only five per cent involved fixed-wing aircraft while the remaining 95 per cent involved rotary-wing aircraft. Private and business operations comprised 71 per cent of fixed-wing aircraft and 29 per cent of rotary-wing aircraft.

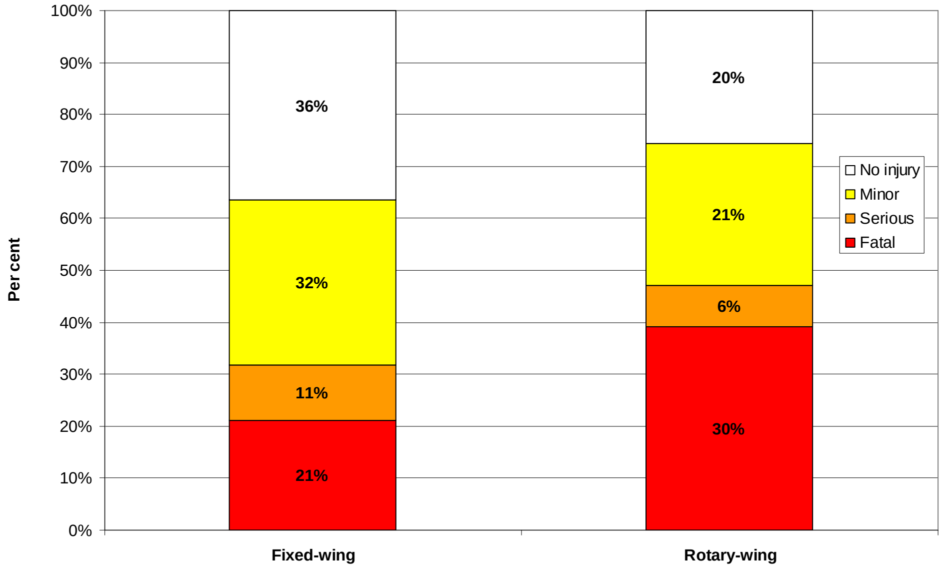
Table 9. Fixed-wing and rotary-wing wire-strike accidents by ATSB statistical categories, 1994 to 2004

Statistical Category	Fixed-wing	Rotary-wing	Total
Charter	1	0	1
Agriculture	50	25	75
Flying training	2	0	2
Other aerial work	1	21	22
Private and business	12	5	17
Total	***66***	***51***	***117***

Though the BTRE does collect data on hours flown for different categories of operations, detailed aggregation is not available for hours flown at low-level as opposed to hours flown not at low-level. In the absence of specific data on low-level operations, analysis of risk exposure levels for fixed-wing and rotary-wing operations is not possible.

Figure 32 shows that 21 per cent of fixed-wing wire-strike accidents resulted in fatalities compared with 30 per cent for rotary-wing accidents. Furthermore, 36 per cent of fixed-wing wire-strike accidents involved no injury compared to 20 per cent for rotary-wing accidents. In relation to both aircraft types, only a small percentage of occurrences involving serious injuries were reported.

Figure 32. Wire-strike accidents by injury level and aircraft type, 1994 to 2004



4.5.1 Location of wire-strike

Table 10 shows that of the 66 fixed-wing wire-strike accidents reported, the location of the wire strike on the aircraft could be identified in 51 cases. The most common location was the aircraft landing gear (25.5 per cent), the leading edge of the wing (23.5 per cent) and the engine/propeller (21.6 per cent).

Table 10. Fixed-wing wire-strike accidents by location of wire strike, 1994 to 2004

	Number	Per cent
Landing gear	13	25.5
Wing leading edge	12	23.5
Engine/propeller	11	21.6
Deflector - top of fin to cabin	5	9.8
Fin	4	7.8
Other	3	5.9
Windscreen	3	5.9
Total	***51***	***100.0***

Table 11 shows that, of the 51 rotary-wing accidents involving a wire strike, the location of the wire-strike on the helicopter could be identified in 35 cases. The most common location was the helicopter main rotor or rotor mast (37.1 per cent) followed by the landing gear (22.9 per cent).

Table 11. Rotary-wing wire-strike accidents by location of first wire strike, 1994 to 2004

	Number	Per cent
Main rotor/mast	13	37.1
Landing gear	8	22.9
Bubble	4	11.4
Tail rotor	4	11.4
Other	3	8.6
Windscreen	2	5.7
Spray boom	1	2.9
Total	***35***	***100.0***

Table 12 shows that of the 117 wire-strikes accidents involving a fixed-wing or rotary-wing aircraft, 50 per cent of the aircraft received substantial damage and 49 per cent were destroyed. A greater proportion of rotary-wing aircraft were destroyed (59 per cent) compared with fixed-wing aircraft (41 per cent).

Table 12. Wire-strike accidents by aircraft damage level and aircraft type, 1994 to 2004

	Fixed-wing		Rotary-wing		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
Destroyed	27	41	30	59	57	49
Substantial	38	57	21	41	59	50
Minor	1	2	0	0	1	1
Total	***66***	***100***	***51***	***100***	***117***	***100***

5 DISCUSSION

Between 1994 and 2004, the rate of wire-strike accidents for GA operations showed signs of decline, particularly in 2002 and 2003. It is possible that drought conditions may have influenced low-level flying activity for these years, and in turn, influenced the corresponding accident rate. The rate for 2004 showed a return to previous accident levels. However, the overall numbers are too small to draw definitive conclusions about the implications of this increase to the incidence of wire-strike accidents during low-level operations.

During the period studied, aerial agriculture operations had an accident rate that was considerably higher than other general aviation categories. This was may have been influenced by the amount of flying conducted at low-level. The other aerial work category recorded the second highest accident rate, possibly reflecting the higher level of exposure to low-level flying relative to the other GA categories.

The percentage of wire-strike accidents involving fixed-wing aircraft (56 per cent) was slightly higher compared with rotary-wing aircraft (44 per cent). Given that there were seven times more fixed-wing aircraft than rotary-wing aircraft in use, rotary-wing aircraft were over-represented in the data. This may reflect the nature and proportion of low-level flying conducted in this aircraft type. Furthermore, the unique capabilities of rotary-wing aircraft may give them greater exposure to hazardous low-level flying environments compared with that of fixed-wing aircraft.

Of the 240 people involved in wire-strike accidents, 19 per cent sustained fatal injuries and nine per cent sustained serious injuries. With regard to aircraft type, 30 per cent of occupants of rotary-wing aircraft involved in wire-strike accidents received fatal injuries compared with 21 per cent of fixed-wing aircraft. Although the numbers were too low to assess whether this was significant, the finding may suggest that occupants of rotary-wing aircraft are more likely to be fatally injured in the event of a wire-strike accident compared with those in a fixed-wing aircraft.

It was found that a large proportion of pilots had prior knowledge of the wire (63 per cent) before coming into contact with it. Although this report did not investigate the human factors that may have been involved in the events leading up to a wire-strike accident, it is possible that one factor may have been pilot distraction. Evidence that many pilots already knew of the existence and location of powerlines supports claims that distraction is one of the major causes of wire-strikes during aerial agriculture and other aerial work. Other human factors that may be involved might include stress, fatigue, workload and visibility.

The findings of this report suggest that the aviation industry would benefit from further research into wire-strike accidents. Evidence of the relatively high number of occurrences where the pilot was aware of the powerline before it was struck suggests that this issue warrants particular attention. Further research should also include an examination of the human factors that may be associated with the situational awareness of low-flying pilots. The Australian aviation industry would also benefit from research on measures that may assist pilots to become more attentive and alert to wires during low-level flight.

6 CONCLUSION

The information presented in this report provides an overview of wire-strike accidents in GA operations and their associated characteristics for the period 1994 to 2004. The key findings indicate that 117 GA wire-strike accidents were reported to the ATSB during this period, with an average of 11 accidents per year. Of the 240 people involved in a wire-strike accident, 45 were fatally injured. The findings also pointed to the relatively high number of occurrences associated with aerial agriculture operations, involving both fixed-wing and rotary-wing aircraft. Another interesting finding was the high percentage (63 per cent) of pilots who were aware of the wire before they struck it.

In line with Australia's declining fatal accident rate (ATSB, 2006a), the findings showed that the number of wire-strike accidents had decreased between 1998 and 2003. The highest number of wire-strike accidents occurred in 1997 and 1998 and the lowest number was recorded in 2003. An increase in accidents was observed between 2003 and 2004, with nine accidents occurring in 2004. While this marked a rise from the previous year, the number of accidents for 2004 was below the annual average for the period.

Subsequent to the analyses presented in this report, 2005 saw a slight decline in the number of wire-strike accidents. In total, four accidents were reported to the ATSB during 2005. None of the accidents resulted in a fatal injury, however one resulted in serious injury and the other two in minor injuries. Again, the contribution of aerial agriculture operations was evident, with both of the accidents in this category occurring during spraying operations.

During the first quarter of 2006 three additional wire-strike accidents were reported to the ATSB, two of which were fatal. While the final ATSB investigation reports for these fatal accidents are yet to be released, the circumstances suggest that low-level flying continues to take a toll on aircraft and occupants. Moreover, the accidents continue to highlight the need for the aviation industry to be proactive in ensuring that appropriate measures are developed and implemented for reducing the occurrence of wire-strike accidents. This includes the development of specialised and adequate training for agriculture pilots who operate extensively in low-level wire environments.

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