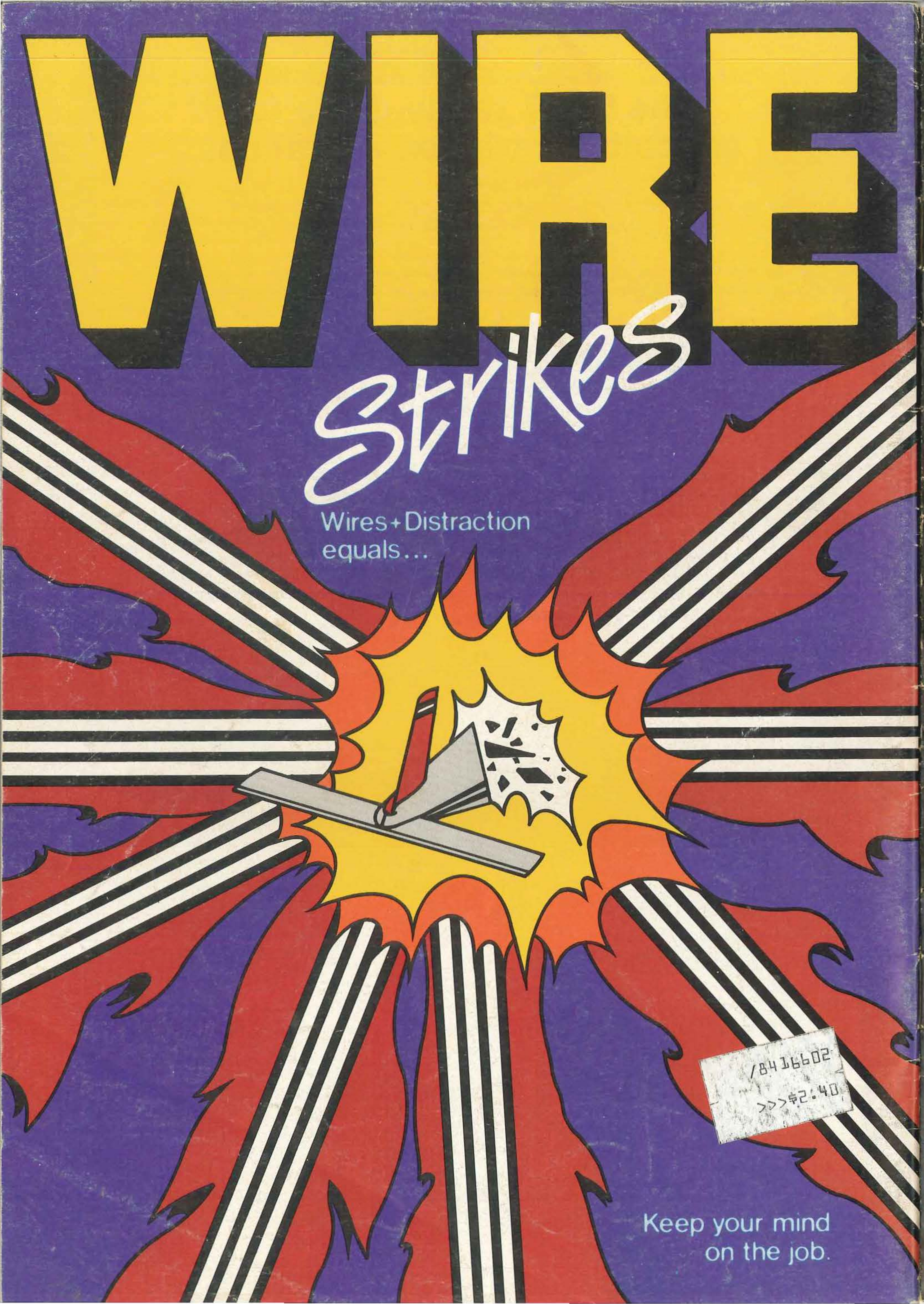




AUSTRALIA

# Aviation Safety Digest

## SPECIAL AG. ISSUE

BUREAU OF AIR SAFETY INVESTIGATION

1985

# Contents



**Front cover**

The Australian-produced Transavia Skyfarmer T-300A


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# Editorial

1983 and 1984 saw one of Australia's most severe droughts broken by widespread and consistent rains. Initially the precipitation was welcomed by the whole rural community, but early in 1984 floods and rain damage to crops had produced a different set of problems.

The breaking of the drought was also welcomed by the agricultural aviation community as it brought with it a long awaited increase in contracts for aerial spraying and other flying activity. Regrettably the increase in activity has been accompanied by a corresponding increase in the number of aircraft accidents.

The continuing high rate of accidents and the increase in the overall numbers is causing the Bureau concern, so this special agricultural edition of *Aviation Safety Digest*, consisting of a selection of articles previously published in the *Digest* and a number of new items, is directed specifically to operators and pilots of aircraft involved in agricultural operations to reinforce the need to maintain professional standards. While some of the articles are based on data several years old, they remain typical of the problems agricultural operators must resolve.

In the current circumstances it would be surprising if every opportunity was not taken to make good, to the maximum extent, the losses which occurred during the drought years. The Bureau, however, is concerned that, coupled with increased activity, there should be increased awareness of the very high risks that accompany any degradation in the standards for safe operations. The recent increase in the numbers of agricultural accidents, although probably to some extent a product of increased activity, is a clear indication that safety standards must never be relaxed.

As the selection of articles in this special *Digest* indicates, the range of safety matters requiring the serious attention of agricultural operators is considerable: pilot fatigue, the handling of chemicals, flying clothing, experience, operational techniques and conditions, wire strikes and aircraft equipment are some of the important issues addressed in this magazine.

Wire strikes, of course, continue to be the major cause of accidents and fatalities, and it is for that reason the topic is emphasised here. There are two lengthy articles on wire strikes, plus another on the physiology of the eye which explains that it simply is not possible to see wires in time to avoid them — pilots must know ***before*** they take off where wires are and, while inflight, they must look for ***signs*** of wires such as poles, insulators on poles, and cross-trees.

The danger of distraction is also highlighted. Distraction is one of the main reasons for wire strikes, particularly in relation to wires the pilot already knows are there. Deteriorating weather, financial pressures, marital problems and pre-occupation with securing other jobs are typical of the distracting influences which can affect inflight performance. Pilots must make every endeavour to keep their mind on the job immediately at hand and deal with other problems only when they are safe and stationary on the ground. Distraction is a killer.

It is also significant to note that BASI statistics show that it is not just inexperienced pilots who are involved in accidents. For example, the majority of wire strikes involve pilots with over 3000 hours flight time and who are over 30 years of age.

Familiarity and complacency are potentially lethal for all pilots, but even more so for the agricultural pilot.

(Paul Choquenot)
Director
Bureau of Air Safety Investigation

# Operational and environmental pressures on the agricultural operator and pilot

*A paper presented to the Aerial Agricultural Association of Australia by C. J. Freeman (Department of Aviation)*

In the early days of agricultural aviation in Australia and indeed up to and including the mid 1960s, agricultural aviation was in the main confined to broad acre topdressing and spraying operations. There was a small percentage of application carried out upon more intensive crops but this work did not really take off until the late 1960s when the dual impact of wheat quotas and lower demand for wool forced many operators to reduce the scale of their operations and look to cash crop application as a means of diversification and survival.

During the 1960s many areas that had not been previously served with mains electricity and relied upon wind generation of power, etc., became connected to the State grids.

Following the advent of Rachael Carson's book *The Silent Spring* the layman began to take more of an interest in his surroundings and the effects of many substances upon his wellbeing and that of his children, when previously much had been accepted as just part of living.

We saw old words take on new significance. Where one was used to the word 'environs' meaning those areas closely surrounding a particular place, the word 'environment' appeared on many lips describing and relating to the wellbeing of the air, water, earth, flora and fauna.

The word 'polluted' used generally to infer contamination by excrement and this gave way to 'pollution' describing any area where an existing desirable thing was contaminated by another substance deemed to be undesirable.

It is easy to see a head of problems building up from this for both the operator and the pilot, and they did.

Operationally, the industry is now presented with a vast network of single wire earth return power lines linking almost every building in all but the most remote areas. This has had a marked effect upon broad acre operations and goes hand in hand with the previously existing wires encountered in the diversified areas of vegetable, vine application etc.

New and more sophisticated chemicals have required more exacting application which in itself places a greater load upon the pilot who is already dealing with extra wire pressure.

We have seen a proliferation of large towers carrying TV aerials in country areas, and now the pilot finds that the air is not all his once he clears tree height. Indeed, he may not be the only aircraft at very low level in country areas, for we now have low jet routes and aircraft used for stock mustering to contend with, plus an expanding fleet of ultra-light aircraft.

Many aircraft now being operated are more sophisticated, expensive and not as readily available as those of 15 years ago.

The urban sprawl and the new awareness and assertion of individual rights means that the pilot must be more aware of his flight path and areas of potential complaints to authorities.

Greater productivity is required because of steeply escalating costs.

The combination of all these factors means more pressure upon the pilot with an increased risk of distraction at a time when concentration upon the job in hand is more vital than ever before.

The operator over recent years has faced increased costs to the tune of 100 per cent on labour and materials and aircraft costing two to three times that of the early 1970s, while we all know of the massive increases in the cost of aviation fuel.

Additionally, the operator faces threats to his continued operation in areas where complaints regarding aircraft noise and use of agricultural chemicals is seen to be a threat to people living there.

The conservationists have seized upon the application of agricultural chemicals as a means to foster their demands and desires for a clean and unchanging world. Such a world, I fear, may have a society much smaller and different to the one we know, for we cannot, in the foreseeable future, maintain our existing level of full bellies throughout an exploding world population without the use of agricultural chemicals to overcome those plants, insects and fungi that strive to take food from us. I believe that no one would argue with the contention that lack of food might precipitate world conflict much quicker than lack of oil. Even so voices are raised against agricultural chemicals, and where a problem develops and an agricultural aircraft is known to have been in the area, the aircraft is almost invariably suspected and blamed.

Unfortunately aircraft are more conspicuous than ground-borne spraying equipment, and the agricultural aircraft, because of its mode of operation, is seen by the public together with other pilots and aircraft operators who do not understand the complexities of agricultural aviation operations, to be performing in a dangerous and irresponsible manner.

For this and other reasons it is more important now than ever before to ensure that operations are conducted in accordance with the Department of Aviation's safety and legal requirements. Most aviation insurance policies specifically require that, for the policy to be in force, all relevant ANOs and ANRs are complied with.

It may well be, of course, that in this changing environment some amendment to the Department's legislation could be effected to retain the safety requirements of the Department whilst being valuable to you as operators and indeed to Australia as a whole. If you believe this to be so then it is in your interests to put reasoned arguments to the Department in justification of those amendments which in your view are necessary. ANO 20.21, 3.2, which sets the horizontal and vertical distances from occupied buildings to be maintained when carrying out agricultural operations, was one case in point and, following protracted representations by your Association, the Department amended the Order.



As previously stated, legal operations are most important for the operator, the industry and the public. The scope and potential of insurance claims has increased to a very large extent over the past decade. It is possible that an insurance company may not be as keen as before to settle a claim if it is in the order of $100 000 for an aircraft with the added possibility of a very large sum for third party. Refusal to settle a claim due to a particular ANO or ANR not being complied with could cause most operators to go to the wall.

Well, it all sounds pretty gloomy, so what do you do about it?

First you must be just as certain as before that what you are doing is right and of great benefit to Australia.

Agricultural aviation contributes a very large amount to export income for Australia.

It helps feed us, clothe us and supply us with good things to drink.

It provides a most important segment of employment and expertise in general aviation, and it provides Australia with a nucleus of highly experienced pilots skilled in low level operations should we need to defend our country against an aggressor.

By better training you can overcome the problems faced by pilots in dealing with the more diverse work undertaken by the industry in latter years and the increase in physical difficulties in getting at that work.

By better public relations you can make the public and your compatriots aware that you are not daredevil cropdusters having a good time, but that you are doing a proper and useful job of work.

Through the Association working closely with the Department you can ensure that present and future legislation relating to agricultural operations is reasonable and practical and allows normal agricultural operations to be carried out safely with a degree of productivity.

You can keep your industry viable and profitable despite high costs by ensuring that your prices are sensible, by using efficient, well-maintained equipment, by actively promoting the benefits of aerial application to the rural sector and government instrumentalities and by displaying high standards of safety and efficiency in your operations.

Brave words maybe, but it *is* the correct way ●

# Aerial agricultural accidents in Australia: an overview

## Introduction

The Australian aerial application industry developed subsequent to World War II. During the early years of the industry, the most commonly used aircraft was the DH82, or Tiger Moth. Both spraying and spreading on crops of millet, barley and cotton are included in early Bureau of Air Safety Investigation records. A perusal of the BASI accident records revealed that the first (recorded) aerial agricultural accident occurred in 1948 in Queensland when, during a spray run, the landing gear of a DH82 entangled in the crop and the aircraft overturned.

The first recorded wire strike (the most common aerial agricultural accident) had occurred a year earlier when a DH82 struck wires during illegal low flying.

The first recorded aerial agriculture fatality occurred in 1950 when a DH82 struck wires while returning to base after spraying barley.

The factors associated with these early aerial application accidents include:

— errors of judgment
— operated without due care
— pilot distraction
— poor technique
— flew into own spray cloud
— used farmer as ground marker and flew into him.

Additionally, there are numerous reports of aircraft being overturned by wind gusts or blown into fences.

Agricultural flying is a demanding aviation task which involves very low level flying operations, with spraying runs just above the crop surface; often, the pilot flies into his own suspended chemical cloud. The pilot is subjected to rapid and changing accelerations, dust, haze, glare and extremes of environmental temperatures, turbulence and varying wind conditions. The pilot may also have an associated heavy physical workload, due to refuelling, chemical mixing, loading hoppers etc. Additionally, the very nature of the work dictates that dawn till dusk operations are the norm, often at remote locations with minimal support facilities.

Finally, most of the current generation agricultural aircraft are designed to provide the maximum utility and workload, with a minimum of comfort for the pilot.

Today's aerial agriculture pilot must be an agronomist, economist, meteorologist and chemical engineer. Besides the day to day work of flying, the operator/pilot will also have to cope with all the associated financial, economic and social considerations of running a business.

When placed in such situations where there are so many extra factors pre-loading his normal demanding flying duties, the chances of an accident are increased, particularly if the pilot has to cope with the unforeseen emergency.

## Statistical overview of aerial agricultural operations

Accident rates in aerial agricultural operations are now higher than for any other segment of general aviation.

| | *No of accidents (fatal)* | *H flown (100 000s)* | *Accidents/ 100 000h flown* |
|---|---|---|---|
| 1973 | 54 (6) | 151.1 | 35.74 |
| 1974 | 43 (3) | 122.5 | 35.10 |
| 1975 | 24 (2) | 79.9 | 30.03 |
| 1976 | 14 (1) | 83.7 | 16.73 |
| 1977 | 22 (1) | 106.9 | 20.58 |
| 1978 | 23 (2) | 127.7 | 18.01 |
| 1979 | 35 (5) | 131.7 | 26.58 |
| 1980 | 30 (5) | 130.8 | 22.94 |
| 1981 | 29 (2) | 119.1 | 24.35 |
| 1982 | 24 (2) | 87.6 | 27.40 |

These rates are approximately twice those of any other segment of aviation apart from the private/business sector. However, unlike the agricultural sector, private and business rates have been steadily declining over the past decade.

**Accidents/100 000 h flown**

| | *Agricultural* | *Private/ business* | *All GA operations* |
|---|---|---|---|
| 1976-80 | 21.35 | 23.65 | 15.28 |
| 1977-81 | 22.56 | 21.20 | 14.40 |
| 1978-82 | 24.10 | 19.95 | 14.20 |
| **Fatal accident rates** | | | |
| 1976-80 | 2.41 | 2.14 | 1.33 |
| 1977-81 | 2.43 | 1.88 | 1.25 |
| 1978-82 | 2.73 | 1.88 | 1.32 |

In most segments of aviation there is a demonstrated relationship between activity and accident rate.

Generally,

— as activity goes up, accident rates decline
— as activity goes up, total number of accidents increases.

Correlation provides a measure of the degree of association between two variables. Generally, the higher the correlation coefficient, the more closely two variables are related.

Within the agricultural sector, correlation did not reveal a strong relationship between activity and accident rate/or number of accidents. Perhaps a better index of activity than reported hours flown is needed for agricultural operations. An alternative index that may be more appropriate for agricultural operations is the number of 'cycles' or takeoffs and landings. Seven takeoffs and landings/h is a reasonable estimate for agricultural operations. If accident rate/100 000 h is divided by for example 7 cycles/h, then the accident rate in the aerial agriculture sector is appreciably reduced. Similarly, if two to three cycles/h are used for the private business sector, the accident rate/cycle is reduced:

1982 — Aerial Agriculture — 3.9 accidents/100 000 cycles (7 cycles/h)
— Private/Business Sector 6.65 to 4.9 accidents/100 000 cycles (2 to 3 cycles/h)

## Profile of agricultural accidents

Over the past 5 years to 1982 the most frequently occurring agricultural accidents have been:

— collision with wires and poles;
— engine failure/malfunction; and
— groundloop/swerve.

Of a total of 171 agricultural accidents between 1979-84, 48 involved collisions with wires or poles, 27 were engine failures or malfunction and 15 involved a groundloop/swerve.

This indicates that there are unique problems associated with aerial agricultural operations. The other surprising factor to emerge is the consistency/familiarity of these types of accidents with those of the very early days of aerial agriculture flying DH82s.

Collisions are the most common accident type, and include collisions with wires/poles, trees and bushes, or crops, and, even in some cases, surface vehicles.

The very first aerial agriculture fatality was a wire strike; one of the earliest recorded fatalities was a collision with an automobile.

Approximately 80 per cent of all accidents involve pilot factors. This is consistent with overseas data from the U.S., Israel and Canada. The data for aerial application operations is also consistent with that for other sectors of general aviation held in the BASI Accident and Incident data base.

## Pilot factors associated with accidents

The pilot factors that are associated with aerial agricultural accidents reflect fairly strongly the type of accident in which agricultural pilots are involved. The pilots' daily workload is demanding, involving early starts, long flying hours, frequent takeoffs and landings, several hundred 180 degree low level turns, frequent negotiations of telephone and power lines, continuous exposures to noise, vibration, 'G' forces and chemicals in addition to a wide variation of temperatures. Several studies have shown that heat alone can cause deterioration in pilot performance.

Among the pilot factors cited as associated with aerial application accidents are:

— misjudged height and clearance — obstacles
— misjudged horizontal/vertical clearance — obstacles
— improper in-flight/taxi decisions
— selected unsuitable landing/takeoff area — agricultural pilots do not usually have ideal operating areas
— inadequate pre-flight preparation and planning — the aerial agricultural pilot needs to be familiar with peculiarities of the local environment, e.g. terrain, local wind or meteorological conditions, and to have an up-to-date 'mud map' detailing the treatment area, susceptible crops, obstacles, wires and masts
— miscellaneous — did not see or avoid objects or obstructions

Analysis of the BASI accident base shows that the agricultural pilot involved in an accident typically has

— 5 000 h total;
— 1 000 h on type; and
— has flown 60-90 hours the previous month,

The strongly held belief that the young and inexperienced are the most accident prone of agricultural pilots is statistically untrue.

Typically it is the experienced pilot who is likely to be involved in an aerial agriculture accident.

This may reflect a situation similar to that of the road accident scenario, in that the greater the degree of exposure, the higher the probability of being involved in an accident. In simple terms, the more you fly, the more likely you are to be involved in an accident.

The Israeli experience is that of 1 accident per/600 h flying and it is estimated that each of their aerial agriculture pilots has been involved in at least 1 accident (Gribetz *et al.* 1981). Accident rates during the peak of the cotton spraying season in Israel approach 150 accidents/100 000 h flown (Richter *et al.* 1981).

**Comparison of accident rates for aerial application operations (per 100 000 h flown) U.S., Israel, Australia**

| | *1974* | *1975* | *1976* | *1977* | *1978* |
|---|---|---|---|---|---|
| U.S. | 22.4 | 19.7 | 17.3 | — | — |
| Israel | 22.72 | 33.33 | 55.0 | 27.27 | 70.83 |
| Australia | 35.10 | 30.03 | 16.73 | 20.58 | 18.01 |

## Fire after impact

Most aerial application pilots express concern about the incidence of fire after impact. For the period 1979-84 in Australia, of the 171 aerial agriculture accidents there were 26 reports of fire after impact, about 15 per cent of the total number of accidents. Of these accidents, there were 17 fatalities.

Not only is fire a concern but so also is toxic exposure to the chemical hazards of pesticides or herbicides and the solvent bases they are contained in should fire break out with or without ignition of the hopper load.

## Aircraft damage

Of the aircraft involved in accidents in 1979-84, about 25 per cent were destroyed and the majority of the remainder sustained substantial damage.

Of these crashes, 17 resulted in fatalities, 14 resulted in serious injury and 140 involved minor/no injury.

Although aircraft damage was substantial, only 12 per cent of the accidents (or 23 of the damaged aircraft) accounted for 17 fatalities. Therefore, not all of the aircraft that were destroyed or substantially damaged resulted in a fatal injury.

A recent cost study initiated by BASI has estimated the cost of a fatal accident at approximately half a million dollars, and that of serious injury at $40 000. These cost estimates include hospitalisation, aircraft hull damage/loss and the value of future lost work.

Using this study as a base-line, the cost (minimum) estimate of these accidents is approximately $9.0 million.

Given that there are about 200 licensed operators in Australia, this represents a substantial underwriting burden to the industry of about $7500/yr/operator over the past 6 years ●

# Dress for crash survival

Each year a number of pilots are killed in survivable accidents. One reason some die so tragically and unnecessarily is their omission to wear suitable protective clothing. The use of protective clothing is an integral part of military flying, but unfortunately the practice has not become widespread in those civil operations — for example aerial application, cattle mustering and oil rig support — which also are relatively high-risk activities. The possible consequences of this omission are unhappily illustrated in the following summaries of two Australian accidents.

- A spraying aircraft crashed while carrying out a procedure turn between spraying runs. Rescuers found the pilot about 10 metres away from the aircraft, which had burnt fiercely. Although the pilot suffered no impact injuries, he subsequently died as the result of extensive burns. He had not been wearing adequate protective clothing; indeed, the material of his clothes tended to absorb flammable liquid rather than resist it.
- During an approach to a property airstrip, an aircraft struck power lines and crashed. The post mortem indicated that the pilot had survived the impact but died while attempting to get clear of the ensuing fire. His clothing had not provided protection.

A recent study of accidents during agricultural operations showed that fire after impact was the main factor affecting survivability. Fire occurred in only 14 per cent of the accidents, but these accounted for over 80 per cent of the fatalities. Over two-thirds of these fatal accidents were survivable but the pilots were overcome by heat and smoke. In addition, serious and minor burn injuries were sometimes sustained unnecessarily.

Some of the fatalities and most of the burns could have been avoided by the use of the protective clothing which is described in detail below.

**Helmet.** The primary function of the helmet is to protect the head, eyes and ears, keeping the wearer conscious so that he can escape from the wreckage. It should be light and shock absorbent with a smooth hard surface to deflect blows and resist penetration. An inner air layer between the shell and the skull is an intrinsic part of the helmet's protective function. The air layer is created and maintained by the use of straps over the head on which the helmet is suspended. These straps must be properly adjusted otherwise protection efficiency will be lost if the helmet is loose and shifts on the head.

The matter of helmets deserves emphasis. There is no valid reason why *all* pilots involved in high-risk operations should not wear a helmet for *all* flights. Complaints such as heat or minor discomfort simply do not hold up when measured against one's life. In a most interesting observation, a very experienced agricultural pilot who has reviewed many accidents has commented that, almost without exception, every pilot he knows who survives a crash without a helmet buys one immediately afterwards. It is not so much a case of closing the stable door, etc., but rather of realising the hard way just how lucky they were and how important a helmet can be.

**Flying overalls.** Overalls protect the body from burns as well as chemicals. For hot climates they are normally made from lightweight cellular cotton. Heavier man-made materials are used in more temperate climates. Nylon should never be used. Any material used ideally should have a fire-retardant treatment. Nomex provides better fire protection than most fabrics but tends to be hot and uncomfortable.

Like all protective clothing, overalls should be kept as clean as possible, especially from oil and fuel contamination.

**Underclothing.** Undergarments should be made from natural fibre. String-type garments are preferable as they increase thermal protection and help keep the wearer cool. Nylon should never be worn against the skin.

**Gloves.** Gloves are essential to protect the hands, particularly when hot buckles, handles, etc., need to be opened.

**Scarves.** A scarf can be used to provide extra neck protection.

## Conclusion

When a flight either does or could involve abnormal risks, aircrew should wear suitable protective flying clothing. Experience has shown that the failure to do so can mean the difference between life and death ●

*(Left) The map provided for the pilot did not show a road which was at an angle to the power line. Although the markers were positioned parallel to the wires the pilot was observed to make his run parallel to the road. On contact with the wires from below the pilot apparently pulled up and the wires severed the right wing. Despite the subsequent loss of control the accident was considered to be survivable but the pilot was not wearing a helmet and was rendered unconscious.*

# Agricultural pilots and skill fatigue

The very nature of aerial agriculture operations places the agricultural pilot in situations where high levels of flying skill and sustained attention are necessary to carry out the aerial application task.

In addition to the dangers of fixed obstacles, low height swath runs, and heavy work schedules, work hazards include combined exposure to noise, vibration, g-forces, heat stress, pesticides and dehydration. Together, these exposures are believed to produce slight but crucial decreases in pilot performance, alertness and skill. Post-crash investigations, even after scrutiny for biases, exclude mechanical factors in more than half of the accidents; in-flight errors or lapses were the most frequent attributed cause. Over 80 per cent of all accidents are associated with pilot factors. Fatigue is increasingly recognised as a major contributor to this.

The agricultural pilot must be considered as particularly susceptible to the effects of skill fatigue, due to the very nature of his operations.

### Skill fatigue

Skill fatigue may be described as the decrement in performance associated with work that demands persistent concentration and a high degree of skill.

It is an insidious phenomenon associated with failure of memory, judgment, integrating ability and presence of mind.

It occurs in conjunction with or is accentuated by other factors, such as sleep loss, fatigue or heat.

In aviation operations, it is associated with high workload and sustained attention tasks such as nap of the earth or contour flying.

During low level flying operations there are also significant differences in the pilot's visual workload compared to flight at higher altitudes. Recent research has shown that, at 50 feet, a pilot's average eyescan fixation time is 1.1 sec., in comparison to 4 sec. at 300 feet. Further, at the lower altitude, the pilot is operating at his maximum visual workload capacity in just flying the aircraft, even over familiar terrain.

During low level aerial application operations, the much accelerated and constantly changing flight environment requires rapid perceptual judgments and similar rapid but precise control responses.

Unlike normal flight applications, where adequate time can be allotted to various tasks, this type of flight requires continuous multi-task co-ordination. As a consequence, it seems likely that a degradation in performance will occur if aerial agriculture operations are conducted over extended periods of time. Such extended operational times are inherent to aerial application operations and are often unavoidable.

The consequences of skill fatigue are typically a deterioration in the pilot's performance, an increased effort to sustain a given level of performance, a reduction in spare mental capacity, and characteristic subjective feelings that may include irritability, tenseness, mental sluggishness, tiredness, lack of energy and increasing distraction due to minor discomforts. Such 'symptoms' may be so frequently present during aerial application operations that they are regarded as a normal or intrinsic part of the agricultural pilot's working environment.

### The characteristics of skill fatigue

- The requirement for greater than normal stimuli for initiation of the appropriate responses.
- Errors in timing.
- Overlooking important elements in task series.
- Loss of accuracy and smoothness of flight control movements.
- Unawareness of the accumulation of rather large errors in azimuth, attitude and height.
- Under and over control movements.
- Forgetting side tasks.
- Increased unreliability of reports of what transpired.
- Errors of inattention — failure to scan sky, vision fixation.
- Preoccupation with one task component to the exclusion of others.

- Allowing various elements of operational sequence to appear out of place with respect to one another.
- Easily distracted by minor discomforts, aches, pains, noise etc.
- Progressive unawareness of performance deficiencies.

Fatigued pilots do not always have accidents but their chances of doing so are increased, particularly if they have to cope with an unforeseen emergency.

The capacity to deal with just one more piece of information may overload the pilot's information processing capacity to such an extent that vital information is forgotten, or 'load shedding' during the flying task occurs without the pilot being subjectively aware of any change in judgment criteria or performance levels.

### Conclusions

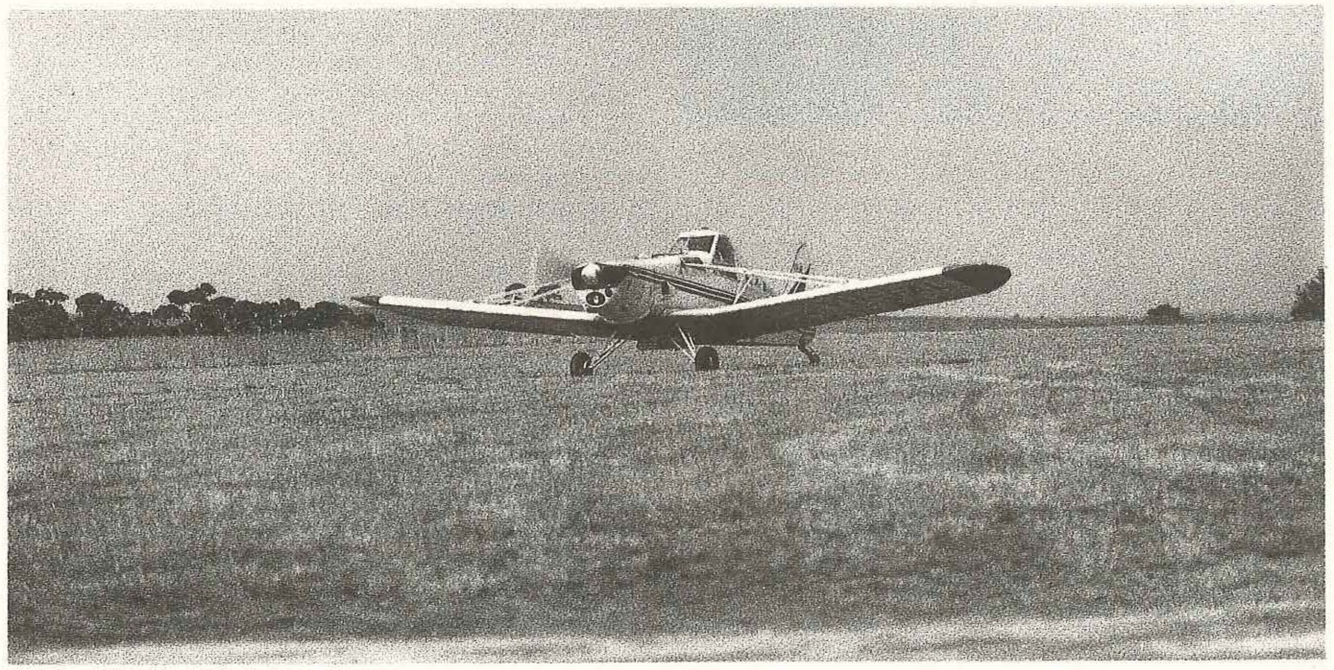
In reviewing what has been said so far, it is evident that there are specific hazards associated with aerial application operations due to the very nature of the flying task itself and the narrow safety margin.

The effects of skill fatigue on pilot performance will always be associated with aerial application work. For the pilot, this may result in performance decrement in an environment where the margin to compensate for error is always small. Such effects on performance may be so often present that they are considered as normal or an intrinsic part of the aerial agricultural pilot's working environment.

The most common types of agricultural accident are a predictable outcome of the sort of performance lapses associated with skill fatigue. Recognition of such consistency of effect and outcome may aid in the avoidance of the accident situation or an understanding of such accidents. Agricultural pilots do not just 'forget' the positions of wires and poles; such lapses are often a predictable outcome of skill fatigue.

### To cope with skill fatigue

- Awareness of what skill fatigue is and the sorts of performance lapses likely to occur.
- Physical fitness, proper diet, adequate fluid intake, breaks during extended flying periods.
- Adequate rest, especially during those duty periods where dawn to dusk operations are unavoidable.
- Reduction of 'outside cockpit' pressures — e.g. business, emotional or financial pressures should *not* be taken into the cockpit:
  - adequate preflight preparation and planning for every job;
  - familiarity with local terrain and peculiarities of local environment, e.g. wind, terrain, markers, power lines; and
  - bioengineering/human factors approach to cockpit design. Awareness of limitations and deficiencies and identification of areas for improvement in cockpit and aircraft design ●



# Wire strikes: the threat and the defence

**Acknowledgement is made to the New Zealand civil aviation safety magazine *Flight Safety* for approval to reproduce this article. Although some of the pilot comments in the article refer to New Zealand locations, the situations, hazards and recommendations apply equally to operations in this country.**

Collision with wires has long been recognised as one of the greatest hazards facing the aerial work pilot. Other than legislating for the non-erection of any wire or cable above ground level — a most unlikely enactment — it seems there is no possibility of eliminating entirely this man-made threat to air safety. In consequence, our wire infested country must continue to be regarded by pilots as a hostile environment in which to operate aircraft at low level.

Much has been written from time to time on the subject, and, as is often the case, it has been easy to be wise after the event and perhaps condemn a normally conscientious pilot for an indiscretion he had no intention of committing. Avoiding overhead wires involves many factors relative to a particular operation, and it is up to the individual pilot to assess the situation and decide on the safest plan of action in the circumstances. However, the continuing high number of wire strike accidents does give cause for concern and suggests that some pilots engaged in this role are either not fully aware of, or are not adhering to, common safety practices and procedures.

Many articles on the subject, apart from outlining general precautions applicable to low level operations and the types of wires likely to be encountered, add little to what many pilots already know.

It therefore became clear that the best possible advice for preventing wire strike accidents should come from those who have done just that over a long period of time. Accordingly, a number of very experienced agricultural pilots throughout the country, with upwards of 20 000 hours in the role and 200 000 sorties flown, were invited to review their long flying careers and explain for the benefit of all concerned — especially pilots new to the industry — how they have managed to escape serious injury or death through wire strikes.

The exercise proved most rewarding. Nearly all the pilots surveyed responded with detailed, modest accounts of the practices and procedures they have diligently maintained with obvious success. Not surprisingly, perhaps, there was general accord on a number of factors considered vital for the avoidance of wires. These are set out in logical sequence as follows. The supporting comments in each case are a composite of views as expressed by the experts themselves.



### Discipline

*The first requirement for safe conduct of any flight, whether agricultural or not, is a strong sense of discipline and self-preservation. This applies to all phases of the flight from aircraft preparation to shutdown.*

*A pilot cannot for a moment allow himself the luxury of relaxing the discipline, no matter what the temptation may be. As the old adage goes, 'Rules are made for the protection of idiots and the guidance of wise men', but a pilot who bends the basic rules has only two chances. He may survive, with a lot of luck, and learn to be a far wiser pilot to carry on to greater things. Without luck, the result is either death or permanent injury, with its pain and suffering. Both not only affect the pilot concerned but also reach to relatives and friends.*

*

*Discipline, being a trained condition of the mind to obey a system of rules, is your primary means of survival in a relatively hazardous occupation. It not only boils down to learning to identify the likelihood of wires and then to spot them; it is equally important to develop good habits as a result of personal discipline at a very early stage in one's career.*

*

*On every briefing, whether it be to topdress, spray poison or supply drop, I discipline myself to ask, '. . . are there any wires — power, telephone, flying fox, television or electric fence?'. Then, while flying out, I watch all the ridge tops. If I see a post or pole, I orbit to locate the wires and align them (or their sag) with a visual reference before continuing work.*

### Memory and awareness

*Once you have identified the obstacles on a particular farm or area keep them etched in your memory for future use. But remember that the human memory is not infallible. Each time you approach the area go about the procedure of asking and observing to refresh the memory, and also find out if any new lines have been erected.*

*

*Some of the most experienced pilots have struck wires, so the problem is not one of an experience gap between the old and the young. It is a matter of being aware that wires and aeroplanes don't go together!*

*

*I suppose it must be part of my background thinking, similar to my fuel management. I always seem to have an internal clock which gives me an image of my position, time-wise, in my fuel endurance. If, for some reason, I become unaware of my fuel state, the sudden realisation is like a shock or a physical blow, even though I may still have an hour's fuel left. The same thing happens with wires. If there is a wire problem on a particular job, I don't consciously remember them, but the awareness is there. If I suddenly realise the awareness is gone, maybe even while landing, it is like the fuel state shock of remembering. The memory lapses may last only about five seconds or even less.*

*

*I am conscious of wires. I don't like the bloody things! Most of my flying has been done in sparsely populated areas where there are fewer wires — unlike Manawatu, Waikato and Taranaki, although I have flown in these areas as well. I put my lack of wire strikes down to the fact that I am always conscious of them. I use the system of repeating to myself in a loud voice, 'power lines' when near potentially dangerous ones.*

*

*I consider power lines to be the biggest hazard by far in top dressing, especially to* experienced *pilots. Although they learn to cope with other hazards such as downdraughts, downwind takeoffs, out-of-wind landings on short strips, etc., the wire hazard is more likely to catch them unawares because of boredom or complacency. One can always pull off a reasonable landing or takeoff when half asleep, but if one hits power lines when half asleep it is probably curtains. My advice to the young pilot is to think power lines every time he flies low or up a gully. This is how important it is to me. The signal starts up in my head every time I head up a strange gully. Even then I sometimes get caught out. It takes a long time to develop the habit, but it is the only answer.*

*

*Once I have located all known wires in an area, I then rely purely on memory. However, for those with any tendency to forgetfulness, a warning placard next to the trip meter, or the word* WIRES *on the job card, are excellent reminders.*


*

*I don't really know if I have any special formula except wire awareness. The need for this awareness was brought home to me by a horrible experience I had many years ago. A close friend and I were working adjacent strips. He was flying a PA18A and I a 225 FU24. The strips were a mile apart and we were working load for load. The main 200 kV lines ran between us, with me turning away from them and the other aircraft turning around them.*

*After our lunch break I was finishing my first sowing run when I looked over towards the other strip. The PA18 was becoming airborne. On my next glance I thought, 'Bloody hell, he's forgotten the wires!' I yelled at him in sheer futility, and at that moment he impacted. The Cub stopped in the air with a blinding flash and was left dangling, caught up in the wires, then caught fire. After a few seconds the blazing aircraft plummeted to the ground. There was no hope of my friend* *surviving that inferno.*

*That experience early in my career still lives with me and contributes greatly towards my constant awareness of the presence of wires and their hazards.*

*

*Try to be conscious of wires at all times. One does tend to forget or become complacent about them, and it is only reading reports and articles on wire hazards, and talking about them, that tends to keep them in one's mind. I must say I have been known to talk aloud to — or rather about — wires. It is an effective reminder.*

## Briefing

*To my mind, the avoidance of wires starts on the airstrip before flight with a positive inquiry to the farmer on the nature and location of wires, not only in the treatment area but also to and from the airstrip. During the subsequent survey, all those wires must be visually located.*

*

*As for on-the-job briefing, it pays to ask again about wires — even for experienced pilots who have flown in the district on many occasions. I just ask: 'Anything new since last time?' Generally, new wires include those connected with television installations, electric fences and sometimes flying foxes. I've had a fright or two with flying foxes when they've been erected for running hay bales across a gully. They are usually temporary things or used only in the winter and spring, and even the farmer can completely forget they are there.*

*

*Most aerial work pilots, at some time in their career, have experienced the situation where a client has assured them there were no wires or obstacles to be wary of, only to be confronted with an awkward situation after crossing the boundary and turning over the neighbouring property. Don't rely implicitly on what you've been told — carry out your own inspection as you work.*

*

*I had commenced operations on a particular property where the sowing runs were parallel to the road. After completing three loads I began working up quite a steep slope to a high ridge, and the farmer, who was assisting me with the loading of the aircraft, casually asked me not to knock down his telephone line. After inquiring further about this hazard, I was informed there was a telephone line running at 45 degrees to my sowing runs. On my next load I located the wire, which ran alongside the road to a point where it cut across the farm and over the ridge. The roadside poles blended in with the boundary fencing and were very difficult to pick up.*

*I later reflected on how lucky I'd been not to have struck that wire. Since that experience, I have always made a point of ensuring that the farmers brief me properly on all overhead wires on their properties.*

*It pays to have a checklist or questionnaire demanding such information as the location of power lines, telephone lines, electric fences and flying foxes on the property.*

## Observation and reconnaissance

*By continual observation of the terrain as habit, it will become second nature to anticipate where the local authorities are likely to erect power or telephone lines in relation to the siting of houses, wool sheds, cow sheds, etc. This is relatively easy on flat terrain, but is more difficult in hill country where lines can be, and usually are, slung from ridge to ridge with no poles in between. It is therefore essential to commence work by flying the ridges first to locate poles and observe the lie of the lines between the poles. It is very dangerous to fly up or down a gully at low altitude before ascertaining first that the area is, in fact, clear of wires.*

*

*Wire strikes often occur when power poles are difficult to see because they are hidden by trees. These accidents commonly take place between the farm house and out-buildings, where the last pole is often obscured by a tree or hedgeline — a classic example of not being able to identify the location of wires by the position of poles. Other accidents commonly occur through striking secondary wires on the same poles (if you are flying under the main wires) or striking earth wires (if you are going over the top). Milking sheds and pump houses should be treated with the utmost suspicion and be investigated for emanating wires if they are not readily seen. Tall structures such as windmills, aerials and some power poles should be checked out for guy wires.*

*

*Some old pilots I know can sniff out wires without being objective about it. Sheer cunning tells them where to look for those hidden wires, or steers them away from places they haven't already checked out. For example an old pilot would never go through a gap in the trees unless he looks at the other side first. He would not skid his aircraft around a pole where the line changes direction unless he checks for guy supports.*

*

*My second wire strike occurred when I arrived at the strip first thing in the morning. I was landing into the east and promptly flew through a set of wires the local power board had erected since I left the previous morning!*

*



*One of the rules I apply to my own operations is never to fly low unless I have first flown over the area at a higher level to assess the flying conditions — looking for likely areas of updraughts, downdraughts, turbulence and the location of wires. I bear these in mind the whole time I am working. If I can't see the wires I picture them as I would the downdraughts, etc.*

*

*I have done mostly top dressing and little spraying, but I think the most significant reason why I have avoided wires is that I am always conscious of them, especially since the advent of low cost electric grass-fencing. Nowadays, before I dart through an inviting looking saddle on a ridge I look to see that the farmer hasn't decided to save himself a couple of poles by stringing a high tensile feeder line across from top to top.*

*

*With my trainees I always impress upon them the golden rule of never venturing into gullies or down rivers, etc., without a prior reconnaissance from a safe height. Whenever flying down a valley keep a good lookout along the ridges above for poles, pylons, etc. They stand out against the sky better than the ground. And always remember that just because you've had a good look around the place, doesn't mean you have located all wires. They can leap out from the most unexpected places. One thing worth mentioning is that it is all too easy to miss a wire during a reconnaissance if it is in close proximity to another, especially if it is smaller and strung with longer spans. It's almost as if the mind has subconsciously 'fixed' that particular area and the eyes look farther afield once the major or first line is located.*

*Watch out in saddles on a ridge that has a fence line running up to it. Sometimes there is a wire running across the saddle. Try to follow every wire you observe slung across a gully or over any long span.*

*

*My own feeling regarding prevention of wire strikes is to have a thorough local knowledge of existing wires and to keep in touch with the authorities responsible for the erection of new wires. Our operations people, as well as the pilots, endeavour to do this and make sure that all are kept informed of wire locations at all times.*

*

*Prior to landing at a farm house (helicopters) check where the power and telephone wires come in. Look for any wires to the pump house, and in hill country look for a television aerial on top of a hill. When approaching the hover, if near a shed, check for electric fences. Watch for odd telephone insulators or broken bottle necks on posts, sticks, pieces of timber or poles stuck in the middle of a fence line. They sometimes have wires strung along them. Along boundaries and roadsides observe the power or telephone pole cross-arms. See that they are in unison. Beware of cross-arms that are at 90 degrees to the usual run. They invariably carry wires running from the main line to a shed or other out-building. The first pole in this secondary line always seems to be hidden behind a tree.*

*I have found it wise to check out the property myself prior to commencing operations. This has a dual purpose. It enables me to remind myself of the property owner's boundary fences and obstructions and to check for any new obstructions erected since my last visit, and provides an opportunity to check that there are no left-behind stock on the airstrip paddock.*

*

## Flying techniques

*There is a height at which a particular aircraft type will give its maximum spread. Below that height the swath width is reduced, but above it the swath width will remain about the same. It may therefore be more desirable to fly the aircraft at heights above the optimum and enjoy that extra margin for error. This applies more so if there are wires in the sowing area. This procedure refers of course to top dressing of fertilisers only — spraying is a different ball game and is best left to helicopters.*

*

*Don't guess the amount of sag of a line if you can't see it. Maybe it is tighter and higher than you estimate. If in doubt, fly higher. It also pays well to, as much as possible, do all turns above ridge top height, thereby avoiding the possibility of tangling with lines that may be slung taut across a gully.*

*

*If there are wires in the treatment area, they should be sighted at every procedure turn before the run-in to spray. This allows you to concentrate later on the lining up and planning of the next swath, and to anticipate the proximity and resighting of the wires at the appropriate time. Where possible, poles should be used as sighters during your approach to the wires as it is far easier to judge both the closing speed and the direction of the wires.*

*Pull-ups should be made early, and the effects of weight and air temperature on performance constantly assessed. However, I have always maintained that provided there is reasonable clearance it is easier and safer to pass under the wires rather than pulling up and over them if they are located in or on the boundary of the treatment area.*

*

*Wire strikes are common on the return for another load. The pilot tends to relax, and his returning flight path and height can be a little erratic as he is not monitoring aircraft performance as he was on the way out. We all tend to be a little inattentive under these circumstances. By sitting up higher on the return trip you can afford to 'rest up' a bit before the next load. Hedgehopping back to the strip achieves a negligible time saving and markedly increases fatigue and exposure to wire strikes.*

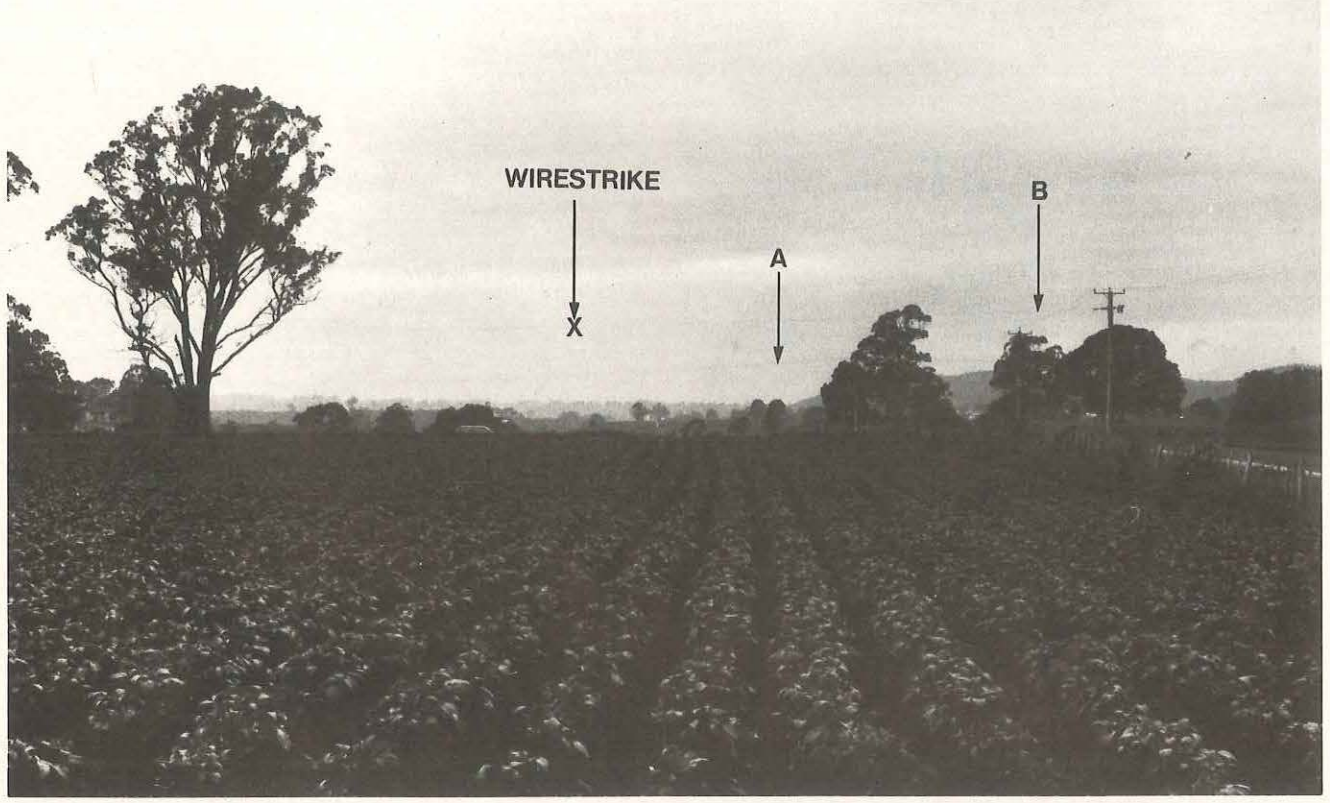
*

The aircraft was returning to the operations base after spreading superphosphate at a nearby property. While flying along the river it hit a power line which spanned the gorge, 300 feet above the river. The aircraft crashed on to the river bank and the pilot was killed.

The poles supporting the wire were widely spread and were difficult to see from the air. The reason for the pilot's operations at low level above the river was not determined.


View across valley showing position of power lines (broken line) and wire strike. Final flight path as described by witness is also indicated (continuous line)
A = rise in foreground — accident site at river level behind rise
B = southern power pole — northern pole is to left of photograph






Constantly change focal length of eye scan ahead — long distance fixation can cause you to 'look through' close-in wires. An accident occurred here when the pilot saw the lower power line (A) in the distance but lost sight of the higher main spur power line (B) in the potato paddock. Note the power poles.

*Plan a flight path that ensures adequate wire clearance. This will look after you should you temporarily forget about the wires. Any deviation to planned track and altitude should be avoided or investigated first.*

*

*Wherever possible, it is better to fly under power lines than to try to scramble over them — as long as you know your aircraft and are experienced enough to judge your height above the ground. Power lines are easier to see against the sky than merged in with the ground. I have several farms in my area with high tension lines on them, and I find it much safer to fly under these lines, alongside the pylons. This way one has plenty of reference — the pylon, the wires and the ground.*

*

*Power line strikes were more frequent a few years ago when dustier materials were being dropped, causing us to contour sow if it was windy in order to get a little more work done. Today with the more granulated supers it is not necessary to fly so low — in fact, it is preferable to sit up higher and achieve a better spread.*

*

*Pilots should constantly change the focal distance of their eye scan along the projected flight path. It is very easy to fix one's eyes on the end of a paddock and 'look through' wires that are within or just outside the boundary. It is also quite easy to fix one's eyes for relatively long periods on objects that gain a pilot's attention, such as loaders and airstrips. This lessens the chance of seeing intermediate obstacles such as wires.*

*

*Ask the farmer about wires during briefing then sight the poles during each sowing run, and if the wires are not visible, fly as high as the poles. Never let the farmer or other operators talk you into flying lower than you feel happy about.*

*

*I think that if a pilot can see he is going to hit power or other lines, he should try to hit them with the propeller. Never, never, with the wings in a turn if it can humanly be avoided.*

*

*During spraying operations I must have flown under literally hundreds, if not thousands, of power and telephone lines. My method is to make an initial reconnaissance around the field to determine the height of the wires, the spacing of the poles, location of trees and other obstacles, the run of all lines (a surprising number go to ground for various reasons) and then confirm the feasibility of the planned spray pattern. After that, the height of the lines becomes secondary to their location, and it's only a matter of following two golden rules:*

- *Look a fair distance ahead of the aircraft and never focus too close.*
- *Never look up at the wires as they approach, but concentrate on maintaining height relative to the ground.*

*

*However, spraying under lines is a different kettle of fish to top dressing under them: firstly because the terrain being dressed is often undulating and the lines not of uniform height, and secondly because of the need to maintain at least a moderate height for spreading purposes, thereby lessening the separation between the aircraft and the lines. I generally discourage top dressing beneath power lines, although there are some situations where it is the best procedure.*

*

*Another hazardous situation exists where wires are the same height, or higher than sowing height, and a climb has to be made every time to avoid them. In this situation if I cannot see both poles clearly I use some other prominent feature as a marker to start climbing. A reassuring back-up procedure is to get an early altimeter check on the height of the line. I've used this method when working in poor visibility (rain, dust, sun, glare, etc.), and also as a safety factor when a good visual sighting of the wire can't be made but other markers are clearly visible. However, the altimeter should never be used as the sole method of assuring wire clearance.*

*

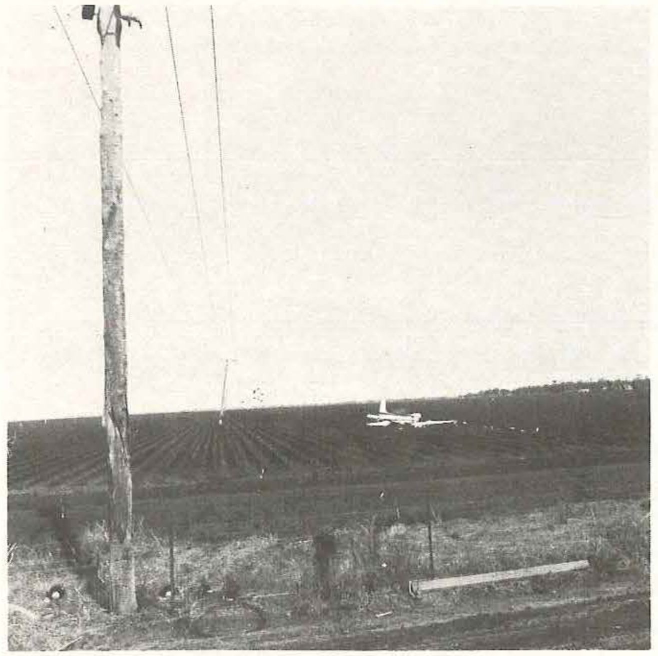
*Some farms have a real confusion of wires running across them. If the farmer wants his spray job done in the area of the wires, explain that you will have to spray from above them. Don't duck and dive, there's bound to be a set of wires that you have forgotten about. Don't try to 'just miss' the wires as they are too difficult to see properly for judging distance during momentary glances.*

*

*Try to spray parallel to the wires. If at any stage you have to spray towards them, pull up well clear of them and complete the unsprayed section later with one or two parallel runs. It may take longer, but it is much safer.*

## Weather factors

*At sunrise and sunset, and for about one hour or so each side, it is almost impossible to detect lines, poles, pylons or obstacles when flying directly into the sun. It is better to leave the job until another time, for surely you are courting disaster by trying to fly blind. Where possible always plan runs so as to avoid this situation.*



*The pilot was spraying a large cotton paddock which had power lines along its northern and western boundaries. During a procedure turn at the western boundary the right main gear leg struck the power line. The procedure turn was made towards the sun. At the point of impact the power lines were higher than elsewhere on the line.*

*

*One of my more serious power line strikes was caused by disorientation in rain. I ran into a rain squall in the middle of a sowing run. I knew the power lines were there but thought I had miles of room above them, and steep turned away. I was horrified to see the wires wrap around the port wing. The only thing to do in a case like this is to keep turning — which I did. The wires eventually shorted and burned through, but not before I had pulled down two concrete poles and a hell of a lot of wire. This brought home the lesson — 'exercise extreme caution when flying low in rain'. I was amazed at the misjudgment I had made in height because of it. This is a very important factor —* low flying over power lines in rain is very dangerous.

## Ferry flights

*When flying from job to base or from job to job, fly at a regulation height above terrain. It is amazing the number of wire strikes that have occurred during positioning flights. Many ag. pilots seem to think that the regulations for cross-country flying do not apply to them. I can relate several cases of wire strikes that would not have happened had the 500 ft terrain clearance minimum been adhered to.*

*

*The need for prior reconnaissance of an area from a safe height to locate wires applies equally when ferrying from base to job, and vice versa. In many areas there are logical bad weather routes from the job to base and it pays to know these intimately. Every now and again it pays to follow them when coming home in good weather conditions to keep an eye on any developments — poles going in, erection of flying foxes, etc. It takes a lot of worry out of the next bad weather trip. I had an incident with a set of 11 000 volt power lines back in 1966 when I had only been in the area a short time. After I had done about an hour's work one morning, a front moved in with accompanying low cloud and light rain. I then headed back to base, but being unfamiliar with the area I elected to follow the Manawatu River which I knew passed close to the aerodrome. Unfortunately, I struck the wires which span the river between a hill on the northern side and a pole set well out on a flat on the southern side. Fortunately, the Beaver struck the wires with the propeller and chewed its way through them, with only moderate damage to the wings and fuselage.*

## Summary

From the foregoing, the principal safety factors for avoiding wires may be summarised as follows:

### Discipline

Without a strong sense of discipline you are bound to succumb to temptations that inevitably lead to dangerous, unplanned manoeuvres. Get to know the safety rules and adhere to them rigidly on every operation.

### Memory and awareness

Be constantly aware of the existence and lethality of wires on every spraying/sowing run, on every flight to and from the treatment area, on every ferry flight to and from base. Don't let complacency, boredom or sleepiness interfere with your mental attitude to wires. If some form of memory jogger is required, use any method that is guaranteed to gain and maintain your attention. Etch WIRES into your mind.

### Briefing

A preflight briefing from the farmer is essential to confirm the nature and location of all wires and significant obstructions on his property, especially in the treatment area and along the route to and from the airstrip. He may also be able to warn you of such hazards on properties adjacent to his boundaries. All these wires and obstructions must be visually located during the subsequent inspection.

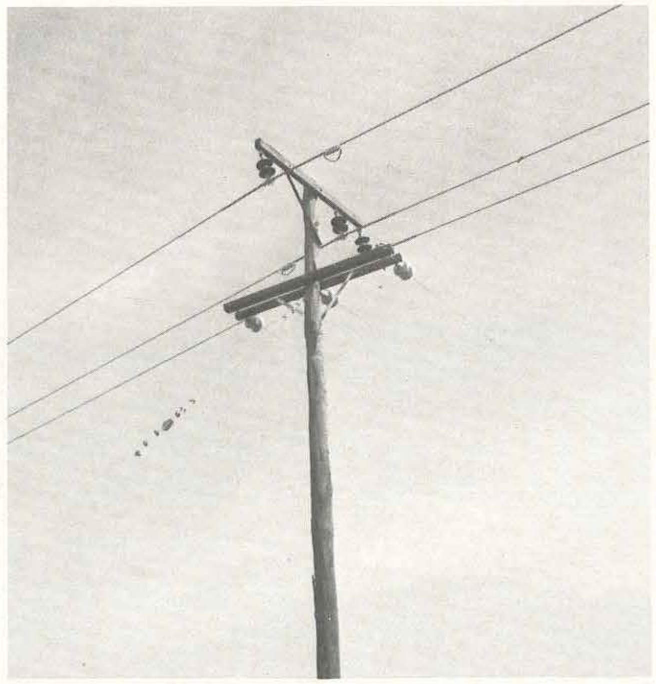
Treat with caution any assurances that there are no dangerous wires on the property. Farmers are apt to forget about old or seldom used lines, flying foxes, electric fences, etc., and even newly erected aerials and cables. Carry out a further inspection if in doubt.

Use a checklist to ensure that no item is overlooked. If necessary, use a map of the area to positively identify and mark in each hazard.

### Reconnaissance and observation

Continual observation of the terrain in your general area of operations enables early recognition of current or likely erection of power and telephone lines in relation to farm building projects.

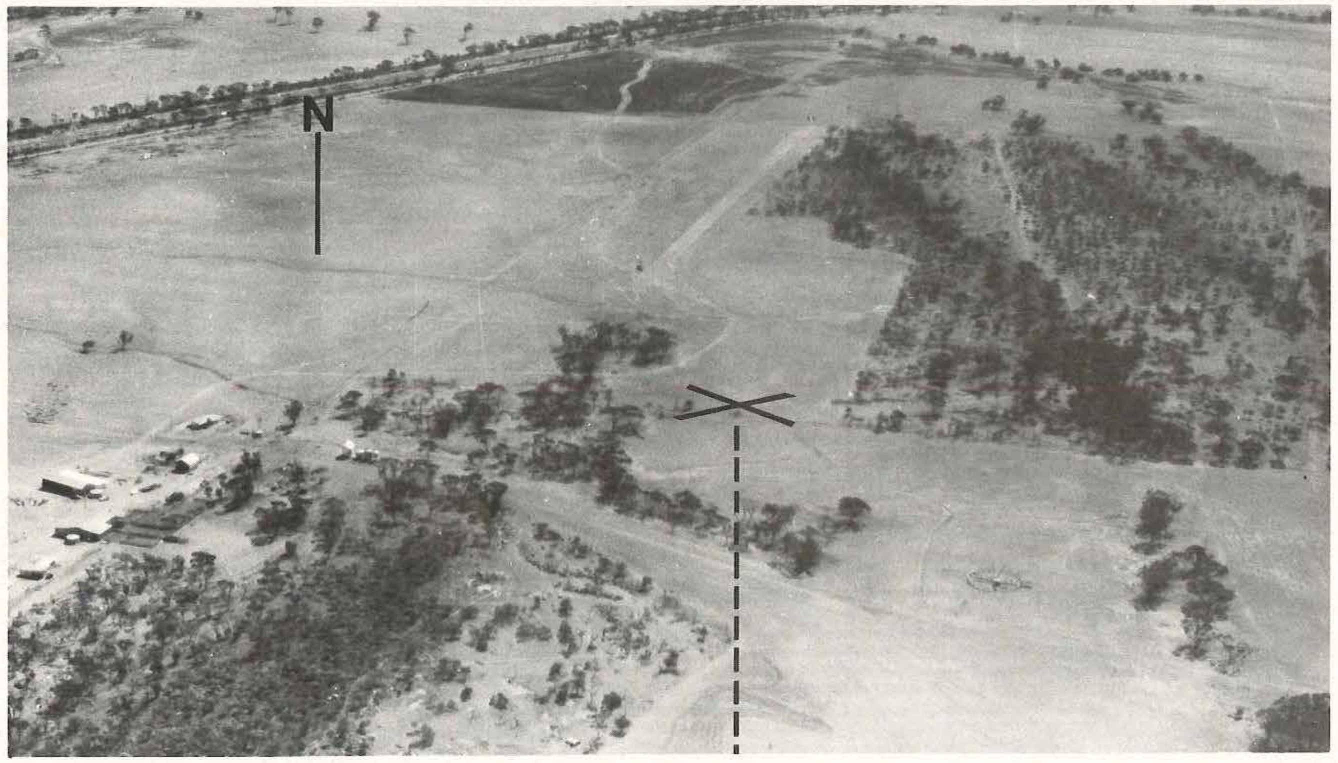
Before commencing work, make a reconnaissance of the total area at a safe height. Positively locate all power pylons and power and telephone poles. Look for those partly obscured by trees, those with cross-arms denoting secondary lines and those forming part of a fence line. Determine the direction of wire runs and spur lines (especially electric fence lines or feeder lines



slung between saddles or ridges). Locate radio and television aerials, supporting guy wires on structures, and flying fox cables. Beware of smaller wires slung in close proximity to major lines.

### Flying technique

- Allow an extra margin for error by flying sowing runs higher than the optimum for maximum spread — the swath width will remain about the same, particularly when granulated material is being used.
- Where possible, make all turns above ridge top




*Wire strikes often occur when the poles are hidden by trees.*
*An Airtruk on final approach to land in the clear area to the south-east of the strip struck double power lines, the supporting poles of which were hidden among the trees shown in the photograph.*

*The first requirement for safe conduct of any flight, whether agricultural or not, is a strong sense of discipline and self-preservation.*

height to avoid wires slung across gullies and saddles. Wires in the treatment area should be sighted on every procedure turn before the run in.

- Where possible, use poles for sighting wire runs, and if the wires are not visible fly as high as the poles. Whenever poles cannot be seen clearly, use some other prominent feature as a marker for the pull-up point.
- Don't guess the amount of sag in a line that is difficult to see. If in doubt, fly higher. It also pays to get an early altimeter check on the height of a wire.
- When establishing a pull-up point to clear wires don't forget the effect of high gross weight and air temperature on aircraft performance.
- Endeavour to make runs parallel to wires. Where you have to spray toward wires pull up well clear and finish untreated areas later with parallel runs.
- With high power lines it is sometimes safer to fly under them; providing there are no other obstructions, that you look well ahead when approaching, that you never look up at the wires as you pass under and that you concentrate on maintaining height above ground. This technique is mainly applicable to spraying — it is not generally recommended for top dressing.
- Where a farm is covered by a profusion of wires, don't 'duck and dive' — maintain a safe height above them at all times, no matter what the effect on spread.
- Maintain extra vigilance when returning for another load, and also during final 'tidy-up' runs. The tendency to relax and be inattentive to detail at these times is a common cause of wire strikes.
- Develop a 'rubber neck'. From takeoff to touchdown keep looking up and down, left to right — everywhere — for wires, obstructions and possible forced landing sites.
- Constantly change focal length of eye scan ahead — long distance fixation can cause you to 'look through' close-in wires.
- Finally, if you are going to hit wires of any sort, try to hit them with the propeller, never with the wings in a turn.

### Weather factors

Never plan or make runs into a rising or setting sun. If you can't avoid sunglare by completing the job across or down sun, delay the operation until such time as glare conditions become less hazardous.

Beware of operating in rain showers: misjudgment of height, and distance from wires, can result through disorientation or visual illusion.

### Ferry flights

Maintain regulatory minimum height above terrain during all ferry flights. If a bad weather route can be followed carry out a reconnaissance in good weather to identify the location of newly erected wires and other hazards.

### Conclusion

That so many highly experienced agricultural pilots have succeeded in flying for so long, in such a demanding role without serious injury, is clear proof that wires can be avoided, simply by placing self-preservation above all else. Other aerial work pilots, whether experienced or new to the industry, would do well to study and put into practice the precautionary measures adopted by the experts in this field.

It really boils down to establishing a personal set of safety rules and disciplining oneself to adhere to them at all times ●



# Low level turbulence

**Turbulence can be classed as second only to wire strikes in the order of hazards facing the agricultural pilot.**

When looked at practically and analytically the problem of low level turbulence is not insurmountable. The two main causes of turbulence at low level (up to 1000 feet AGL) are:

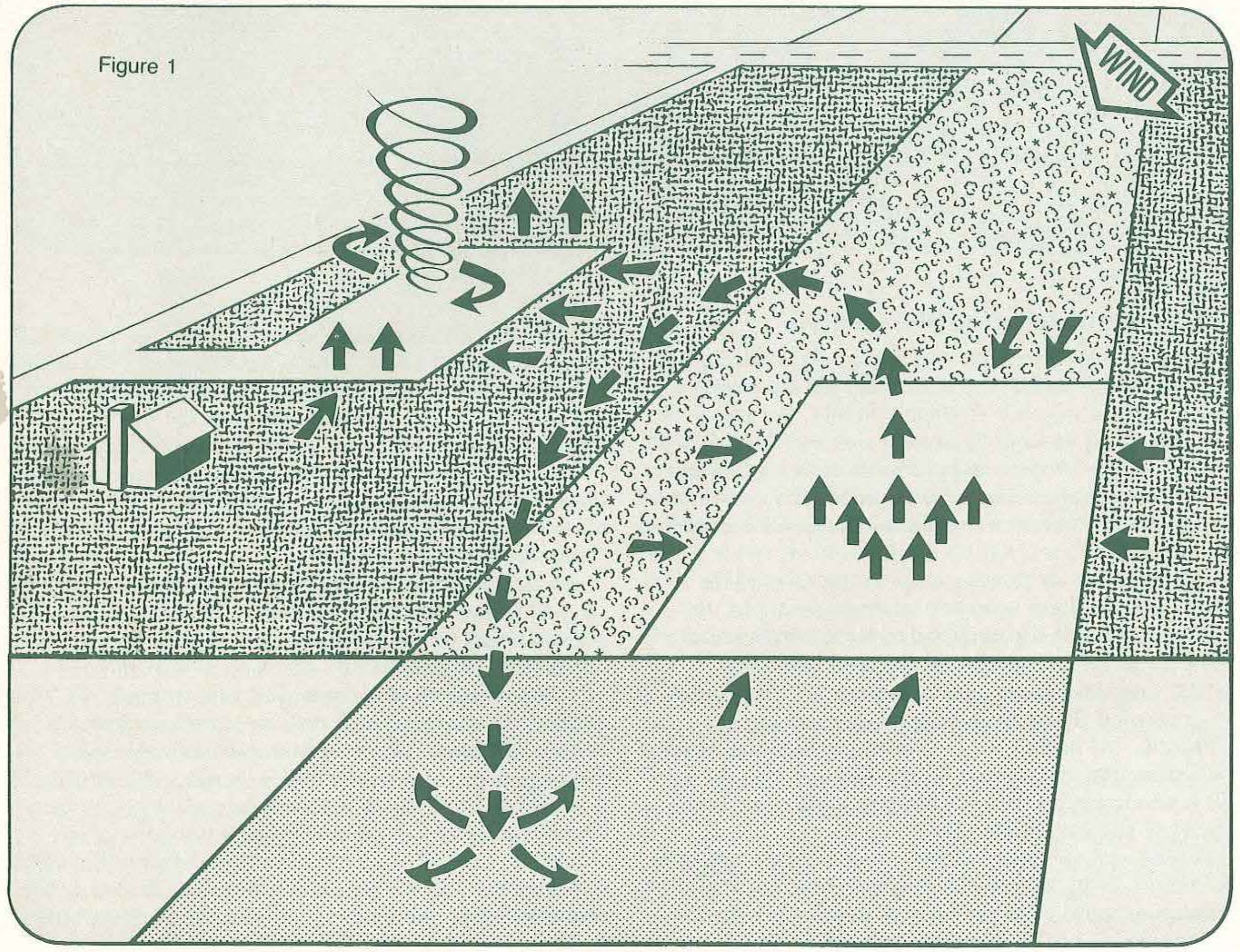
— Thermal movement of air
— Mechanical disturbance of an airflow

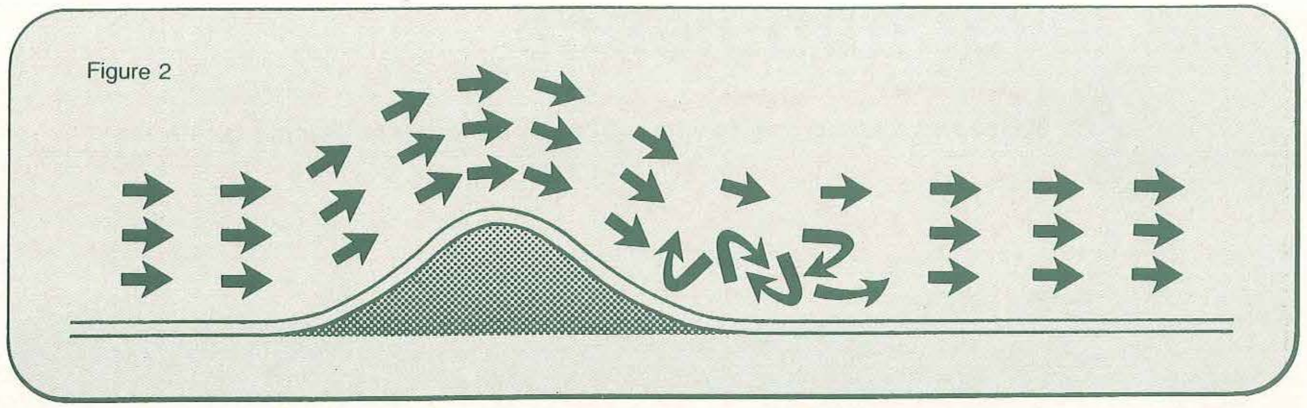
## Thermal movement of air

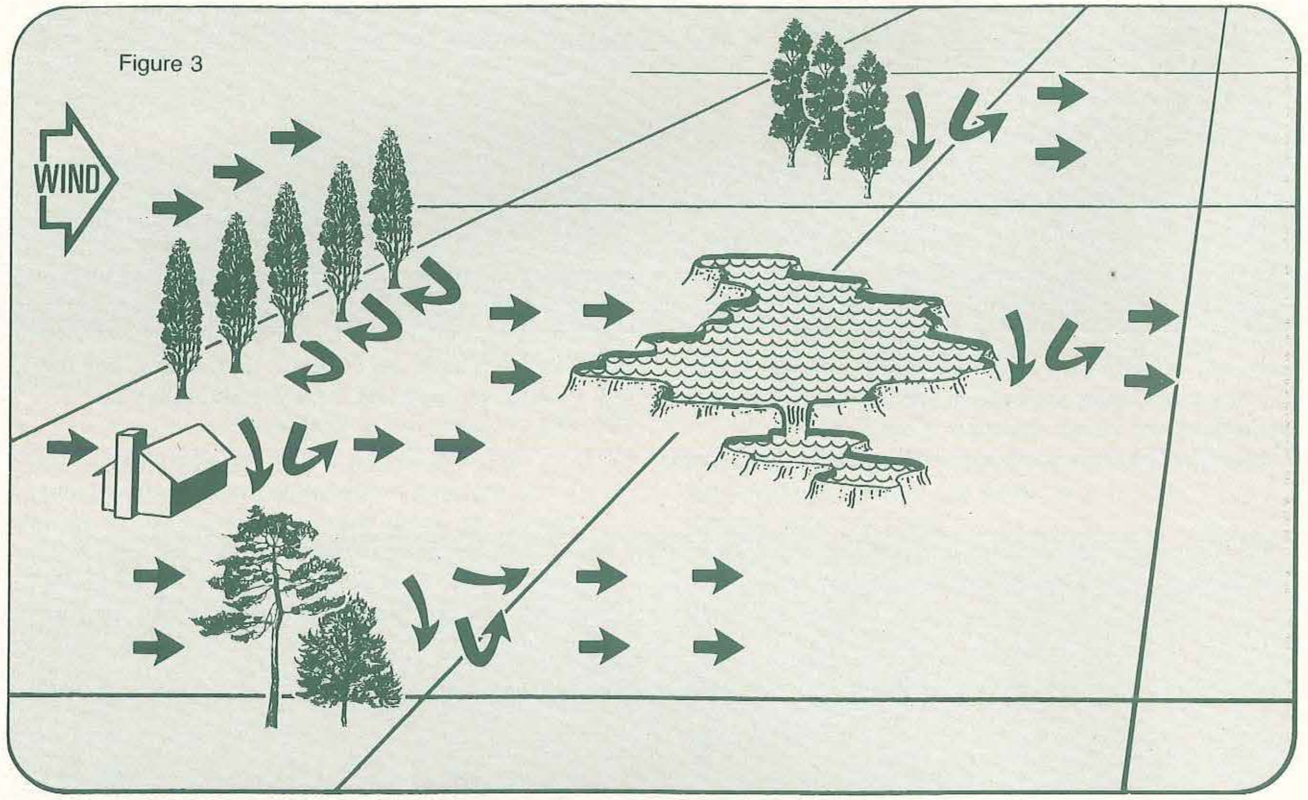
Rising parcels of air (thermals) are caused by air being warmed to different temperatures over different surfaces. For example, on a sunny day, a newly worked-up paddock in sandy country, surrounded by fully stooled crops which cover the ground with a thick green canopy, will have a much higher surface temperature. The bare ground will supply much more heat to the air than will the surrounding crops. This hotter air will rise by convection and an aircraft flying over the crops, then the bare paddock, will be carried upwards by the rising air when it comes to it (Figure 1). The upward motion will cease as the aircraft flies out of the rising air.

Of course some air has to replace the rising air over the bare paddock. Cooling parcels of air descend in other places and move in to replace the rising air. Both are happening at the same time and this raises and lowers aircraft flying through the various parcels of rising and descending air (Figure 1). Aircraft operating in close proximity to the ground are most obviously affected.

Moving air always has a small rotation and this becomes concentrated as the air moves towards the centre of the low density area. If the heating is quick and the contrast in temperatures is high this will result in a more violent rising of the heated air; the inflowing cooler surface air will move in rapidly with a twisting movement and give birth to a vertical vortex — the 'willy-willy' (Figure 1). Aircraft operating at low level and passing through this air will indubitably be affected, perhaps with critical results.






## Mechanical disturbance of an airflow

Air flowing across terrain of varying height during the day will tend to follow the line of the terrain. This brings about a number of effects. Firstly, the air on the upwind side of an undulation will rise and on the downwind side of an undulation will descend (Figure 2). An aircraft operating on the windward side will also rise (updraught) and on the leeward side will descend (downdraught).

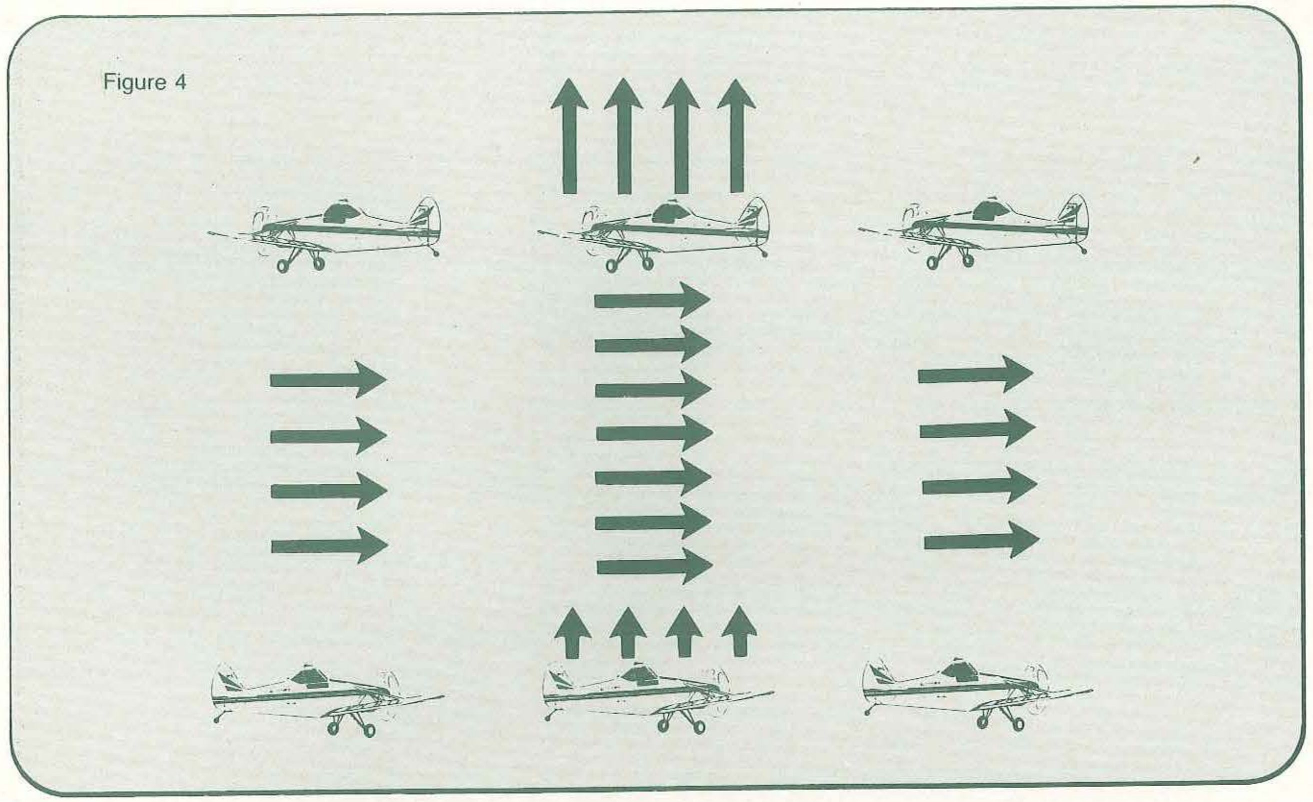
Secondly, the air flowing close to the crest of the undulation will have a higher relative speed and the local effect upon an aircraft flying from windward to leeward will be a reduction in airspeed due to its inertia, and this results in a loss of lift. The reverse is the case when flying from leeward to windward.

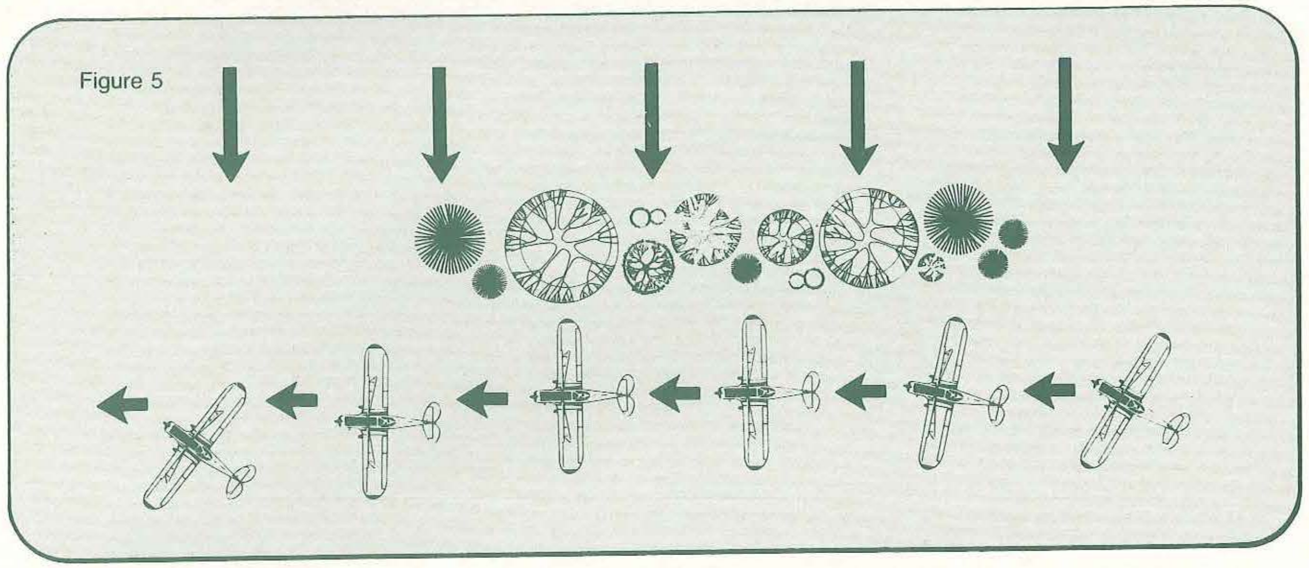
Thirdly, the airflow on the windward side will tend to be streamlined, whereas on the leeward side the air will tend to break away, resulting in eddies and swirls instead of the streamlined flow.

To illustrate the effect of these three factors, imagine an aircraft flying downwind across a ridge in undulating terrain. As the aircraft approaches the windward side of the ridge the air rises and so does the aircraft; the air accelerates towards the crest resulting in loss of airspeed and lift; as the aircraft passes the crest it is subject to downdraughts, and eddies and swirls in the air. An aircraft approaching from the other direction will find the eddies and swirls first, together with the downward movement of the air; as it passes towards the crest, there is an increase in airspeed and lift followed by updraught lift on the windward side — classic mechanical turbulence.

Air flowing over obstructions (trees, houses, bridges etc.) will have very little streamline flow and will quickly break into a turbulent flow close to the obstruction (Figure 3). On the upwind side there is virtually no effect, but downwind, the stronger the airflow, the more pronounced the turbulent flow. Where the obstruction is continuous and relatively uniform, e.g. a forest or a belt of scrub, the turbulent flow will be continuous and strongest close to the trees. The same factors apply in a lesser way with airflow across the surface of a crop. Turbulent flow will result and its effect will vary with the nature of the crop. For example, vines and cotton will generate more turbulent flow than a cereal crop like wheat.






One of the products of the eddies and swirls resulting from the above is the interruption and resumption of the normal flow. We know these variations as gusts and they are more pronounced as the airflow increases. An aircraft passing through a horizontal gust from the rear suffers a loss of airspeed and lift due to its inertia, followed by a return to its previous airspeed and lift as it flies out of the gust. Approaching from the front of the gust results in an increase in airspeed and lift while entering, and a return to previous conditions when through (Figure 4). The result is a bumpy ride. A side gust simply drifts the aircraft violently downwind with the drift ceasing just as violently when out of the gust.

One example that is similar to gusts, but belongs in the area covered by Figure 3, is when an aircraft flies crosswind in uninterrupted airflow and passes on the leeward side of a line of scrub or trees. The aircraft already has its drift laid off, so that when the crosswind suddenly ceases the aircraft moves towards the line of scrub, and if it is on a spray run close to the trees, this can be quite awkward. The pilot corrects and flies with no drift laid off whereupon the aircraft emerges from behind the scrub and is subject to immediate drift which moves it downwind until the drift is laid off again (Figure 5).

## Methods to counteract and avoid the problem

Use a combination of common sense and anticipation. A strong wind blowing over a patch of trees is obviously going to generate turbulence. Anticipate it and be ready for it.

An area of cotton or vines with a sealed road and parking area adjacent is going to create sharp differences in temperature close to the ground. One can anticipate, at the least, rising and descending air or, at the most, strong 'willy-willys', so be ready.

*Continued overleaf*

# Chemicals and the ag. pilot

The agricultural pilot operates routinely in a hazardous environment. Exposure to toxic substances is an ever-present hazard. The pilot must be aware of the dangers posed by exposure to the chemical agents he is using and in particular, know how to avoid exposure and recognise signs of poisoning.

Fortunately, amongst the multitude of chemicals currently available for aerial application, only a few cause serious problems because of toxicity. These are generally crop protection chemicals; fertilizers and crop nutrients may cause a little skin irritation among ground crew and general irritation among dusted down onlookers, but do not cause serious harm.

Intoxication by chemical pesticides may occur in ground crew, the pilot and the public. The possibility of intoxication is directly related to:
- the toxicity of the chemical
- concentration of the chemical
  - — before dilution for spraying
  - — after dilution
- the rate at which it is absorbed by the skin
- extent of contamination of skin (and clothing) during handling
- time elapsed before skin and clothing are washed
- duration of exposure over time to the same or closely related chemical.

In addition, hot climates aggravate a toxicity problem by increasing the rate of chemical absorption by the skin and by encouraging 'stripped to the waist' operations which increase the extent of likely skin contamination.

Liquid preparations cause more toxicity problems than do granules. Dust is relatively dilute, but also very pervasive, and thus is about mid-way between liquids and granules in terms of risk.

The risks of contamination are related to personal exposure rates. Thus those who fill up the aircraft with chemical are at the greatest risk. Where the pilot does this himself, he adds the ground crew risk to the pilot risk. The statistics indicate that such single handed operators are amongst the most likely casualties of pesticide operations.

The pilot's personal exposure during the actual spraying is extremely limited. During the tight turn downwind, he may certainly run into his own spray discharge, but even then contamination is likely to be very slight. The only important consequence is the chance of local effects such as eye or nose irritation, or the effect on pupil size with loss of clear vision caused by minute droplets of many of the organosphosphate insecticides. Local effects such as these could precipitate a crisis in the air.

There is wide variation in the toxicity of chemicals used for crop protection. Insecticide toxicity is greater than that of herbicides and fungicides. Pilots must always consult the product label or literature to ensure that they are aware of appropriate protective measures.

Minor exposures to chemicals, single or repeated, may cause vague unwellness, taking the sharp edge off mental performance and concentration amongst ground crew or the pilot. If overexposure continues or increases, frank illness or early poisoning may occur.

The risk of accidental or negligent poisoning due to airspraying operations with pesticides may be reduced by the following:
- respect the chemical being used
- know its toxicity
  - — and handle only according to instructions on product label or literature
- use adequate protective clothing
- ensure a high standard of personal hygiene (i.e. cleanliness) in all chemical operations, and clean up spillages
- increase the standards of caution and hygiene adopted
  - — in hot climates
  - — in long operations with the same chemical
  - — where you fill and also spray ●

## Low level turbulence *(continued)*

To help you anticipate and be ready, use common sense in looking for signs of turbulence, both thermal and mechanical.

— Look ahead of the crop you are treating. Gusts quite often show up well, particularly over cereal crops. So do 'willy-willys' which may move crosswind across your path.

— Look ahead in your procedure turn. Gusts will show up on the ground, particularly in the crop. The relative movement of trees will show acceleration and deceleration of air movement. Study the path your turn will take.

— Watch for dust rising; it is always a good sign of a relative change in air movement, both thermal and mechanical.

— Anticipate changes in airspeed and drift caused by gusts and the blanking of wind movement. This will result in the aircraft being less prone to rise and fall in gusts. It will also enable you to track straight when passing in and out of a blanked area on the downwind side of an obstruction.

— Watch for visible meteorological signs — movement of low cloud showing wind speed and turbulence, breakup of fog or mist suggesting an imminent change in surface temperature, condensation or dissipation of cloud on upslopes or downslopes of hills which show topographical uplift or downflow.

You cannot prevent or stop low level turbulence, but through common sense and anticipation you can make it a lot easier to live with — and *live* is the operative word ●



# Landing area standards

Landing is the phase of flight during which most General Aviation accidents occur. In one annual survey of accidents prepared by the Bureau of Air Safety Investigation, 50.7 per cent of GA accidents were found to be associated with this phase. The precise breakdown was as follows:
- Approach 6.9 per cent
- Level-off/touchdown 21.5 per cent
- Roll 16.7 per cent
- Go-around 3.0 per cent
- Other 2.6 per cent

Given that data, it is apparent that pilots should try to ensure that as many factors as possible are working in their favour during landings.

One of those factors is the state of the landing area, where items such as surface condition, gradient, dimensions, elevation and approach path are all important. The hazards attendant in ignoring those items are apparent in the following summary of a landing accident.

* * *

An agricultural aircraft had completed a spraying run and was returning to land on a strip in an oatfield. The strip's width was 15 metres while the aircraft's wingspan was 12.7 metres.

At the edge of the strip the average height of the crop was 1 metre. After the aircraft had made a normal touchdown, the right wingtip contacted a patch of oats growing on a slight mound, and which stood about half a metre higher than the rest of the crop. This caused the aircraft to swing rapidly to the right, in the course of which the fuselage was severely buckled, and the left wingtip and left horizontal stabiliser were substantially damaged.

### Comment

The specifications for Authorised Landing Areas (ALAs) are detailed in the Visual Flight Guide (VFG). Those standards are considered to be the minimum to ensure safe operations over an extended period. As this expensive accident showed, persistent disregard of those standards is likely, in the long run, to catch up with those who choose to ignore them.

It cannot be overemphasised that operations into landing strips will only provide the necessary margin of safety if the strip:
- meets the specification for ALAs set out in the VFG, and
- has been carefully surveyed from ground level.

**Sub-standard agricultural airstrips**

Physical standards for agricultural airstrips are specified in the Agricultural Pilot Manual, Ops 2.1 through 2.3, and are required to be included in Operations Manuals.

These standards were devised to provide an overall minimum standard for safe operations. However, it is impracticable, within the scope of a single set of specifications, to cater for the many possible combinations of physical attributes which may be found in the field and may be considered suitable for operations when considered as a whole.

It is clearly possible for an airstrip which is sub-standard in regard to one or more of these requirements, and above standard in other directions, to be more acceptable than one which just meets all requirements.

Where an operator wishes to use a sub-standard airstrip he is required to obtain prior Departmental approval.

Approval for the use of a particular airstrip may be qualified as necessary by restrictions as appropriate, e.g. aircraft type restrictions, operation category restrictions, pilot qualification restrictions and time restrictions pending future construction work.

Permission for one operator to use a sub-standard strip is not to be taken as a blanket approval for its use by all operators. Each operator who proposes to use the airstrip is required to obtain approval separately, as individual capacities to comply with any restrictions that may have been imposed on use of the airstrip must be assessed.

It is in the personal interests of all operators who wish to use a sub-standard strip to ensure that they first obtain Departmental approval, as the failure to do so could adversely affect insurance claims should an accident occur ●

# The experience factor

**Experience is rightly recognised as being one of the major factors contributing to a pilot's competence. Yet it is not an end in itself, for as the following accident review shows, highly qualified and experienced pilots can still fall prey to the most basic errors if they fail to observe the fundamentals of safe operations.**

A pilot was involved in spreading superphosphate in an Airtruk. While his agricultural experience was limited, amounting to 350 hours total and 40 hours on type, his overall experience level was substantial, consisting of 2700 hours and a Grade One instructor rating.

A second Airtruk was working on the same property: it was being flown by a pilot with about 10 000 hours agricultural flying time. Both aircraft were operating from the same airstrip, and work progressed uneventfully during the morning, with breaks being taken for morning tea and lunch. The aircraft were refuelled during lunch and operations recommenced.

On the third flight of the afternoon the pilot who held the instructor grading was turning onto his initial spreading run at an altitude of about 150 feet AGL when he felt his aircraft start to 'shudder'. He began a turn to the right towards lower ground and at the same time applied full power and dumped the load of superphosphate. However, the aircraft descended rapidly. Realising that ground impact was unavoidable the pilot tried to control the crash, but with little success. The aircraft hit the ground nose first; the propeller and nosewheel were torn off before the aircraft cartwheeled for 30 metres. It came to rest right way up with the cockpit virtually intact but the aircraft destroyed.

The terrain around the crash site was hilly. The aircraft had impacted on a southerly heading on a 5 degree rising slope, and a short distance further on, the ground rose abruptly by another 400 feet. Wind velocity was from the north-west at 5-10 knots and the temperature was 23°C.

The cause of this accident was straightforward: notwithstanding his experience and qualification as an instructor, the pilot had allowed his aircraft to stall.

An examination of the Pilots Handling Notes for the Airtruk showed that, for the aircraft's weight at the time of the accident, the flaps-up stalling speed was 56 knots. In subsequent discussions the pilot stated that he had been maintaining an IAS of 78 knots. However, the stalling speed of 56 knots was, of course, applicable only to straight and level flight, and in this case the pilot was banking his aircraft to line up on the spreading run — during which he felt his aircraft 'shudder'.

Assuming an angle of bank of between 40 degrees and 60 degrees was used, the load factor on the aircraft would have increased by between 1.4 and 2.0. As stalling speed increases proportionately to the square root of the load factor, the stall speed in this case would have risen to between 64 and 79 knots. Further, the turn on to the spreading run was made over rising terrain (see diagram) and it seems possible that airspeed may have inadvertently been allowed to decay slightly as a constant height AGL was maintained.

In short, the aircraft was being flown close to the ground at a speed which provided no margin for manoeuvring. The 'shuddering' which the pilot felt was pre-stall buffet.

The message here is simple, but that fact does not diminish its importance; on the contrary, it highlights the truism that aeroplanes and the physics of flight are no respecters of experience, qualifications or reputations — if you fail to observe the basics, it CAN happen to you.

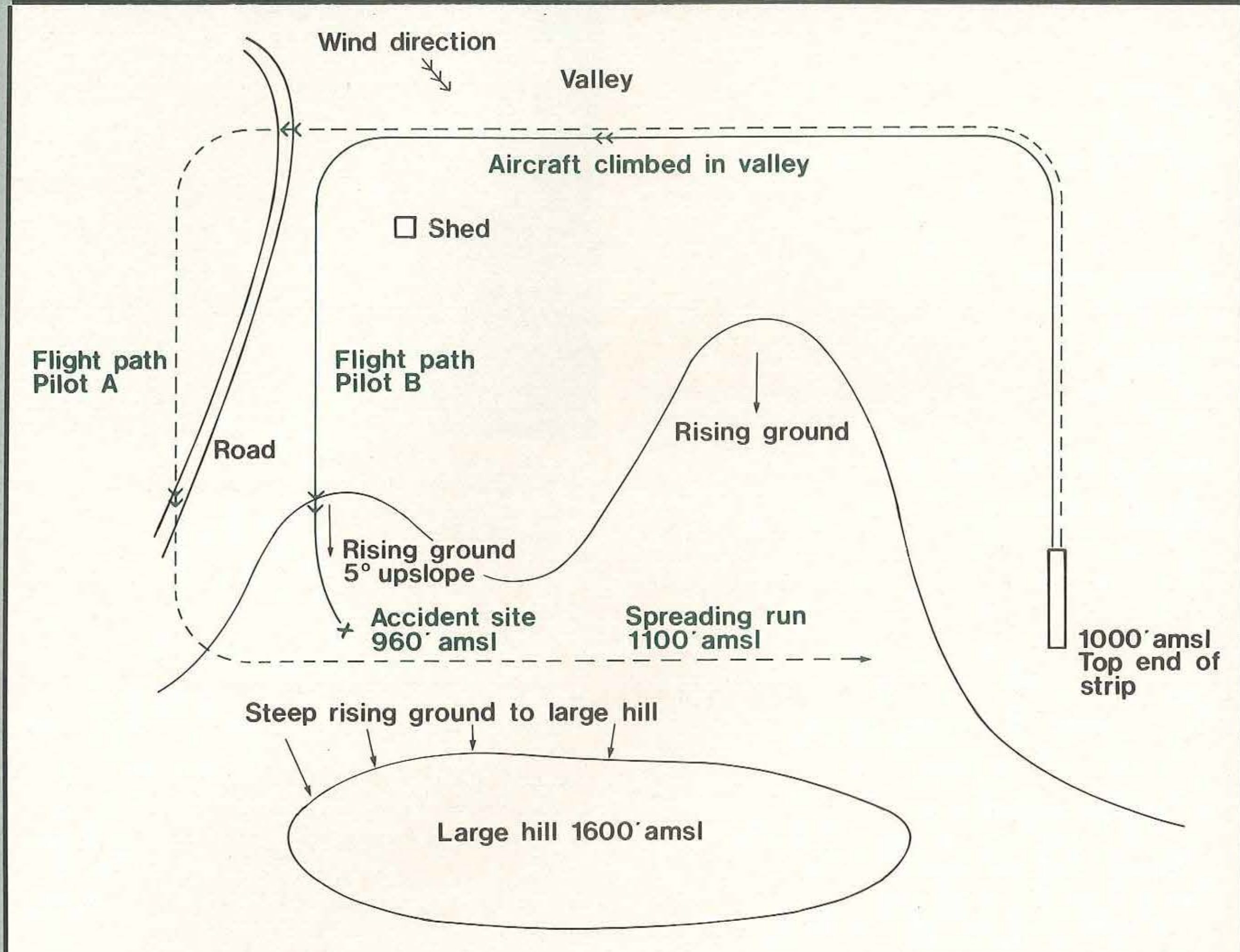
* * *

A further interesting point arising from this occurrence revolves around the circuit patterns flown by the two pilots. At various times before the accident both pilots had flown this circuit. However, the pilot with 10 000 hours agricultural time had flown a pattern which went further downwind on the circuit than that flown by the pilot who eventually crashed (the circuits are marked as Pilot A and Pilot B respectively on the diagram).

By flying further downwind, Pilot A obviated the need to start the turn on to the spreading run while over rising ground, i.e. unlike Pilot B, he did not have to climb while in the turn to maintain a constant height AGL. Unfortunately this procedure was not discussed between the two pilots: given the experience level of each, perhaps they did not feel any need to compare techniques. Yet, clearly, the pattern flown by Pilot A was better planned and safer.

In the sometimes demanding and unforgiving business of aviation, no pilot can afford to take anything for granted. It costs nothing to compare ideas or notes, and while the thoughts or advice of others may often be superfluous, none of us gets it right all the time — regardless of experience. Pilots also need to remember that, as this accident showed, experience in one sphere of flight operations is not necessarily transferable to another. This point is particularly pertinent for supervisors ●



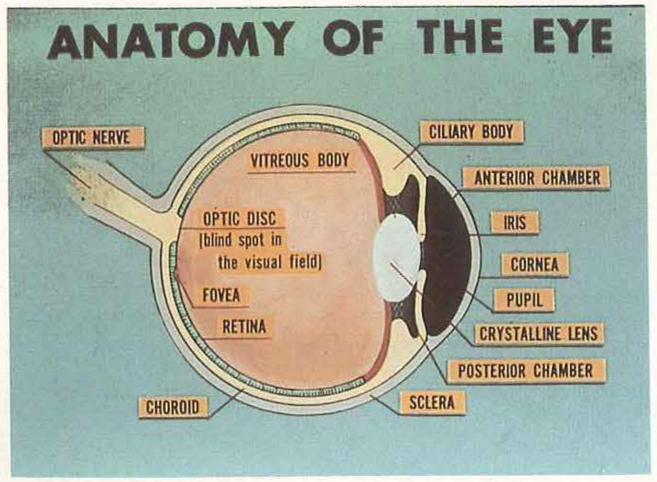



*Looking back along flight path showing valley and rising terrain (right).*

# *Why didn't I see that wire until too late?*

The human eyeball Mark I is a very versatile apparatus that serves us well. It has, however, even with 'perfect' sight, physical limitations in its performance. One such limitation is its power of resolution — that is, the minimal size of an object that can be registered — due to the construction of the sensor, the retina. In some respects the retina resembles the grain of black-and-white photographic film. The grain is the finite size of the sense organs, the cones. (The periphery of the retina is coarse grained and picks up movement but not detail, while the central part is fine grained and registers detail.) As anyone who has enlarged black-and-white film knows, the grain itself limits the detail that can be obtained.

The usual country power line or telephone wire when viewed from a safe (in flying terms) distance makes too small a visual angle for it to register on the cones. How then do we ever see it? Under specific conditions, that is against a plain contrasting background such as the sky, the eye has a compensating mechanism that relies on this contrast. In effect, we perceive the break in continuity of the background rather than 'seeing' the wire itself. Our mobile computer, the brain, happily translates this into seeing. However, reduce the contrast and break up the background and we are thrown back on to the basic visual mechanism limited by the grain (cone) size. The wire literally disappears. It is not 'camouflaged', it is beyond the limits of the eye to see it and no matter how hard we stare, squint or move our heads we will never be able to see it. We are wasting our time looking.




These physiological facts have obvious and important implications for pilots in country areas, particularly agricultural pilots and those who must have a 'closer look'. Where it is necessary to fly low in the course of a job, up-to-date charts of line obstructions must be obtained and supplemented by a ground survey. The extra power line to a shed has frequently appeared since the last time the area was flown. For those who must look closer, an adequate safety height must be maintained and prudence observed wherever pylons can be seen.

Do not, repeat do not, expect to spot wires from the air; your visual apparatus is not sufficiently sensitive, and if you do see them it will be 'too late' ●

## Load dumping

The aircraft was operating from a sloping agricultural airstrip located on one side of a valley in hilly country. The takeoff direction was down the slope. The aircraft was refuelled about mid-morning and when flying resumed, 410 kg was uplifted without difficulty. For the second takeoff the pilot called for the same load, and although the aircraft became airborne before reaching the end of the strip, it failed to climb away and flew down the slopes towards the valley floor. The pilot selected the dump valve but the load did not dump and the aircraft sank onto the hillside, struck several large rocks and crashed. The aircraft was virtually destroyed but the pilot escaped with minor injuries.

A large piece of reinforced packing paper was found in the wreckage associated with the base of the hopper and the louvres. This had probably prevented the dumping of the load. It was also probable that it had prevented the hopper from discharging fully on the previous flight, with the result that the aircraft could have been overloaded for the second flight. Numerous other pieces of packing paper were found in the bulk superphosphate heap at the airstrip. The fertiliser had been transported in rail trucks lined with the paper and pieces had apparently been torn out when the trucks were being unloaded.

The pilot and loader-driver were aware of the presence of paper in the superphosphate heap and had taken some precautions to remove those pieces which came to their notice. The circumstances of this accident suggest that all concerned in agricultural aviation need to be fully aware of the problems posed by the presence of foreign matter in the loads being carried. The effect it might have on dumping mechanisms and accuracy of loading should be particularly noted.

This is not considered to be a situation warranting mandatory procedures, but it would certainly seem that all agricultural operators and pilots should be conscious of the hazard and should implement preventive measures which ensure that the safety of their operations is not prejudiced ●



# Inflight structural damage

**Few emergencies place a greater demand on a pilot's judgment, and capacity to assess calmly all the points for and against possible courses of action, than inflight structural damage.**

Pilots unfortunate enough to find themselves in this predicament sometimes experience difficulty in deciding on a course of action because of uncertainty over the extent of the damage. This doubt can arise when damage is not visible because:

- it simply is not within the field of view, or
- it is beneath the skin of the aircraft.

Structural damage can be caused by a range of occurrences — overstress, wire strike, mid-air collision, bird strike, aircraft components coming loose in flight, ground/tree strike and heavy landings are some that come to mind. The crucial question the pilot must ask himself after such an occurrence is: how quickly should I get the aircraft on the ground? This was a question an Australian pilot had to answer recently.

* * *

A highly experienced agricultural pilot, while flying under power lines, struck them with his aircraft's fin. The pilot must have been well aware that the aircraft had sustained a wire strike, for immediately afterwards a witness noticed the rudder and elevators being checked very positively for freedom of movement and effectiveness.

At this stage the pilot had three options for landing. He could have landed straight ahead into the crop, but with the considerable risk of overturning. As his aircraft apparently appeared to be responding to control inputs, that option probably — and reasonably — did not seem like much of a choice. Second, the pilot could have landed on a dirt road (below) which ran parallel to his final spray run and was some 100 to 150 metres to his right. This road was clear of obstructions and suitable for landing. Finally, the pilot could have attempted to return to his base airstrip, which was about six kilometres from the scene of the wire strike.

By the time the pilot had tested the flight controls and had time to assess his situation, he had flown about two kilometres from the wires towards the base strip and so had only about four kilometres to go to reach it. Thus, it was probably reasonable for him to expect the aircraft to keep flying and reach that strip. Tragically, it did not. While the aircraft was still about four kilometres from the strip it overflew three witnesses, one of whom saw the vertical stabiliser fall over to the right and start flapping. All three could hear the noise of the flapping above the sound of the engine. Shortly afterwards the aircraft's nose dropped and the machine dived into the ground. The pilot was killed. There is little doubt that the damage to the tailplane caused longitudinal control problems which resulted in loss of control and the subsequent crash.

* * *

It is not possible to make categorical statements concerning the actions pilots should take in a situation such as this; indeed, it would be wrong to do so. There are many factors which come into play — for example, how was the pilot to assess the respective merits of a hazardous straight-ahead landing into the crop, against that of remaining airborne in a machine which may have sustained only superficial damage? A landing on the road alongside the crop may perhaps have been a different matter — then again, he was only a couple of minutes flying time away from his preferred site.

In the final analysis only the pilot can assess the relative risks of continued flight in an aircraft which may have sustained structural damage. One thing, however, is certain: if a safe landing area is available and is utilised then those risks have been removed. It is infinitely preferable to assess possible structural damage from ground level ●

# Wire strikes

*'The cause of the accident was that the pilot did not maintain the high degree of vigilance which is necessary when conducting agricultural spraying operations'.*

**Collisions with overhead wires, or wire strikes, continue to account for a significant proportion of accidents involving general aviation aircraft. The following table shows that for a representative 5 year period an average of 10 per cent of general aviation accidents involved wire strikes.**

| Year | Total general aviation accidents | Wire strikes Agricultural | Wire strikes Other |
|---|---|---|---|
| 1 | 256 | 13 | 6 |
| 2 | 208 | 11 | 8 |
| 3 | 243 | 11 | 14 |
| 4 | 221 | 11 | 13 |
| 5 | 250 | 17 | 17 |

**This article contains the text of a paper given by Mr C. J. Freeman to a Convention of the Aerial Agricultural Association of Australia on the problem of locating and avoiding power lines.**

*

Call them what you will but without doubt wires, high tension lines, cables and Single Wire Earth Return lines are probably the greatest hazard facing the agricultural pilot today, whether he is inexperienced or highly experienced.

During the 5 year period reviewed here, wire strikes accounted for 20 per cent of agricultural aircraft accidents in which the aircraft was substantially damaged or destroyed. They also accounted for 40 per cent of all fatalities and 36 per cent of all serious injuries in agricultural operations, so it can be seen that the chance of surviving a wire strike accident is considerably lower than for any other type of agricultural accident. Indeed, as 17 per cent of all wire strikes result in fatal injury and 22 per cent in serious injury, a pilot involved in a wire strike has more than one chance in three of being killed or seriously injured.

These facts are quite obvious to the pilot involved in agricultural operations and particularly in spraying operations, but wire strikes continue. Why?

In a representative ten wire strikes, two involved wires of which the pilot was unaware, one involved misjudgment of wire clearance and seven — that is 70 per cent of all wire strikes — happened when the pilot forgot about a wire he had previously located.

What can be done to reduce the occurrence of wire strikes?

## Wire location

During the training of an agricultural pilot greater emphasis must be placed on working around wires, after locating them from the indications given by poles, insulators, cross trees, buildings and *common sense.* The pilot must realise that the indications on their own are not good enough; he must locate the actual wire. If in doubt he must fly over the pole to locate the wire; he is unlikely to fly into the indication.

The importance of treatment area inspections must be strongly emphasised. Ground inspections are of doubtful value *in determining pole runs and wire dispersal,* and are often impossible. Aerial inspections are better, as the perspective is correct and the chance of a pole being hidden from sight is less because it is possible to see other poles in the run. One problem with an aerial inspection is that, having carried it out, the pilot usually begins treatment immediately and has little time to digest all the information gathered during the inspection.

The problem of transferring an inspection in plan to a treatment in elevation is not great, in fact the inspection is a combination of plan and elevation.

The aerial inspection must be conducted with great thoroughness, starting as the aircraft approaches the treatment area and continuing on into the area. Nothing must be left on the basis of, 'I think that is where it goes'. The pilot must be 100 per cent certain and if he is not, then he must look again. However, he must not fly around the area excessively as this could disorientate him in relation to obstacles. It is also time wasting, and time wasting will eventually apply pressure which could result in mental overload.

The pilot must make proper use of all visual clues. The most obvious are the pole runs associated with the wire run. It is often possible to locate the main feed line (particularly with Single Wire Earth Return lines) and this, combined with the knowledge that dwellings in the area all have power connected, will give an indication of the possible pole and wire runs. The type, number and attitude of insulators indicate the wire disposal on the pole, and if interpreted properly will yield a wealth of information on wire direction, height, tension and so on. Cross trees on the poles indicate supplementary wire runs and the angle of the cross tree, in relation to the main run, will indicate the angle of the supplementary or spur wire.

Finally, it can be said that, as a general rule, in an area where domestic power supply is available, all dwellings and most other buildings have power connected. No attempt should be made to begin a treatment until the wires supplying all buildings in the treatment area have been located.

Always remember, visual clues are only *indications* of wire runs; the wire itself *must* be located.

## Misjudgment of wire clearance

This usually results from one of two factors. The first is that the pilot takes avoiding action too late to clear a wire. This may occur at the end of a run or during a run when there is insufficient clearance to fly under the wire.

To overcome this problem it is essential that the pilot select some reference point at which avoiding action must be commenced in order to provide adequate clearance of the wire. Two situations where use of this technique is advisable are approaching a wide span of wire and when approaching a wire that is at an angle to the flight path. It can also apply when approaching wires which are at different heights, because the highest wire always looks farthest away.

The second factor arises when the pilot finds that the wire he intended to fly under is either lower than he thought or has an obstruction underneath it. In respect of the former, it should be obvious during the inspection that a wire has either adequate clearance or suspect clearance. These parameters will vary as a pilot gains experience.

When the clearance is suspect the aircraft should be flown at spraying height, parallel to the wire, and the clearance physically checked. The pilot can then decide whether he will fly over or under the wire during the treatment.

Obstructions beneath the wire should be located during inspection. During training strong emphasis should be placed on inspecting the surface below the lower levels of the wire run for obstructions and undulations. The fences alongside the spraying run are other areas where the pilot is likely to encounter extraneous bits and pieces of equipment encroaching upon his flight path. When an obstruction is located under a wire during a spraying run, it is usually a small one, otherwise it would have been seen during the inspection.

To avoid it, yaw the aircraft and flat turn slightly. As a last resort hit it (unless it is a human marker). This is infinitely better than striking the wire. There is little other than wires, large trees or new fences that will stop an aircraft, and staying airborne with a wheel, undercarriage leg or spray pump removed is preferable to hitting the ground hard with the aircraft in one piece.

## Strikes on 'forgotten' wires

This problem involves the highest proportion of strikes, deaths and serious injuries, yet is the hardest to solve. During training the future agricultural pilot must be made aware that one fatality in four involves striking a wire that had already been located. While it is essential to locate wires, it is even more important to remember them. The only way to remember a wire is to dismiss all extraneous matter from your mind while engaged in treating an area and concentrate on the job in hand. Easily said but hard to practice, particularly when the chemical or avgas that you expected in half an hour will not be available for another four hours. But it is extremely important, and new minds can be trained to do it. The budding agricultural pilot can also be trained to carry out an extra 'wires' or 'obstructions' check before carrying out clean-up runs. This is the main area of wire strikes and results from relaxation or mental overload, and these two factors can go hand-in-hand with orientation of the treatment area and obstructions changing through 90 degrees. The RAAF carry out an extra 'wheels' check on final approach. Maybe a mental 'wires' check would be a professional approach to this problem.

We are losing experienced pilots as well as new men. Most industry pilots would be aware of a number of highly experienced pilots, with many years in the industry, who have lost their lives through wire strikes over the past few years. The industry cannot afford to lose men of such calibre and experience. Some have struck wires and survived; many others have come perilously close to wires they had forgotten about. Remember, it can happen to you even though you have many years and thousands of hours of experience.

The problem of mental overload is uppermost in the case of the experienced pilot. Individuals vary as to the mental load they can tolerate but all must reach saturation at some time and the addition of one more factor will drop some items out of their memory. These items will not necessarily be unimportant ones. To avoid this possibility, pilots must be encouraged to relegate items that do not require their full attention. They must also train themselves to dismiss from their heads all extraneous matters that do not relate to the actual job in hand. They can reduce their mental load by better planning; a properly planned operation reduces the need to carry a heavy mental load. A note pad in the cockpit to jot down items that need to be acted upon at the next landing could reduce this load and accordingly the chance of overlooking a wire.

*Aerial inspections are better than ground inspections for determining pole runs and wire dispersal as the perspective is correct.*

In addition, loader drivers could be trained to accept more responsibility, thus reducing the pilot's mental load and ensuring that his approach to the job is a little more relaxed. The solution is therefore twofold: reduction of extraneous loading on the pilot by better planning, and training of auxiliary staff.

Pilots must realise that their biggest hazard is distraction. It is imperative that they dismiss from their minds all items not associated with the actual treatment. The bullet can't kill you unless someone pulls the trigger: in this case the wire is the bullet, and the distraction is the pull on the trigger.

The causes of distraction are all too well known — chemical not available, avgas not turned up, more work coming in, leaking nozzles, tonight's accommodation, last night's row with your wife or girlfriend, et cetera. The owner/pilot is at the greatest risk for he has business pressures to contend with as well. It is essential that you dismiss these problems until you have landed, when they can be handled without the distraction of having to fly an aircraft as well.

### Familiarity

One last factor is familiarity. No pilot of sound mind feels contempt for wires, but it is possible for him to become too familiar with them and feel less concern than is healthy. Unfortunately, after the battle with the wires in and around the treatment area has been won, they do not fall down or disappear. They stay there and wait — and the war goes on.

To sum up, I am advocating:

- More emphasis on training new pilots in location of wires.
- More thorough inspections of areas under, and close to, wires, particularly where the wire is low.
- The use of supplementary reference points where it is difficult to pinpoint the position of the wire.
- Extra checks before clean-up runs.
- Above all, awareness that distraction from the job in hand resulting from mental overload causes wire strikes with more than one chance in three of death or serious injury.
- Delegation of more responsibility to loader drivers.

Do not let familiarity make you casual in your approach to wire location and avoidance. Maintain high standards and have a healthy respect for the potential death-trap of wires.

In conclusion, it is worth noting that if you hit a wire and you are wearing a crash helmet your chances of survival are doubled! ●



# Unnecessary low level transit = disaster

Aerial application flying is recognised as a high-risk operation. It is because of this that this special edition of the *Aviation Safety Digest* features an article titled 'Wire strikes: the threat and the defence' which addresses dangers faced by agricultural pilots.

Among the matters discussed in the article is that of transit heights while flying en route to or from an application area. It points out that wire strikes are common on transit flights, and that pilots should avoid exposing themselves to this totally unnecessary risk by cruising at a comfortable height as 'hedgehopping back to the strip achieves negligible time saving and markedly increases fatigue and exposure to wire strikes'.

The risks inherent in needless low level cruises are not restricted to wire strikes. Should an aircraft sustain a malfunction precipitating a forced landing, then obviously the aircraft's height AGL is going to be a crucial factor in the execution of that landing. As an old saying goes, 'Altitude above you is like runway behind you'. It is a maxim which has relevance to all pilots, but especially those of single-engine aircraft; and it was unhappily illustrated in the following fatal accident.

* * *

An agricultural aircraft took off in the late afternoon to carry out some sowing on a property about 17 kilometres from the airstrip. After turning on to heading the pilot settled into the cruise at a height of about 100 feet AGL, although there was no operational necessity to maintain such a low level. At a position about three kilometres north of the airstrip the noise of the engine suddenly ceased. The aircraft descended and banked steeply to the right. While still turning, the right wing collided with a large willow tree. The right wing tip then struck the ground and the aircraft cartwheeled before coming to rest 58 metres further on. An intense fire consumed much of the wreckage and killed the pilot.

* * *

Because of the fire damage, it was not possible to determine the cause of the apparent engine failure. It was found that the aircraft was illegally fitted with both liquid-spraying and solid-spraying equipment (only one should be fitted at any time) which would have significantly affected glide performance.

However, notwithstanding the loss of engine power and the illegal equipment configuration, the low cruise height was identified as being a crucial factor in the catastrophic outcome of this accident. Based on the position, heading and height of the aircraft at the time of the apparent engine failure, the most suitable forced landing area was located ahead and to the right. It seems probable that the pilot was attempting to reach this area when the collision with the tree occurred. The collision was a consequence of the pilot not having time for any course of action other than that which immediately presented itself: unless he happened to be virtually on top of a clear area, he simply did not have sufficient height to effect a safe forced landing.

### Comment

The extent to which light aircraft are damaged during forced landings varies considerably. It is, however, a fact that the great majority of pilots and passengers involved in such accidents survive them, often with little, if any, injury.

One of the key factors is that of having sufficient time — which clearly is related to sufficient altitude — to assess the situation and exercise as much control as possible over the forced landing. If you can pick the place, the landing direction, control the airspeed, complete safety checks, etc., then the odds are very much in your favour. On the other hand, needlessly cruising at a low altitude stacks the odds against you to the extent where lives may be placed at risk ●

# The dangers of distraction


Several major articles in this magazine discuss the topic of wire strikes by agricultural aircraft. One of the many points stressed is that of the need for continuous vigilance and concentration on the part of the pilot during aerial application operations. Quite simply, because of the environment in which they work, agricultural pilots cannot afford the slightest lapse of concentration. This truism is yet again illustrated in the two brief but instructive accident summaries related below. The pilot in the first accident had over 18 000 hours flight time, and the second over 9000 hours.

* * *

A cotton field was being sprayed under conditions which the pilot found relatively easy. The only noteworthy obstruction was a single-strand power line which was on a perimeter of the paddock, suspended from poles about 200 metres apart, and which hung down to about 20 feet above ground level at mid-span. To facilitate his task, the pilot settled into a routine of flying under this wire at the completion of every second run.

Conditions were calm and cool, and the pilot had sprayed this paddock on numerous occasions previously. In his own words, it all added up to 'a dead easy job'. Because of this he allowed his mind to wander on to the next job he would be undertaking, and also on to details relating to a personal business venture on which he intended to embark later that day.

Consequently he omitted to descend the aircraft on the penultimate run and saw the power line only when he was almost on it. He dived in an attempt to avoid the wire but struck it with the tail fin. The complete tail assembly was torn from the aircraft and all control was lost. As the aircraft struck the ground the engine was wrenched from its mountings. The airframe continued to cartwheel for 23 metres. The unconscious pilot was extricated from the wreckage by the loader driver and marker.

* * *

While he was spraying a sorghum crop the pilot of an Agwagon noticed that a component of the spraying equipment was malfunctioning. He climbed a little while he rectified the fault and then resumed his job. Shortly afterwards the component failed again, so he repeated his actions and was again successful.

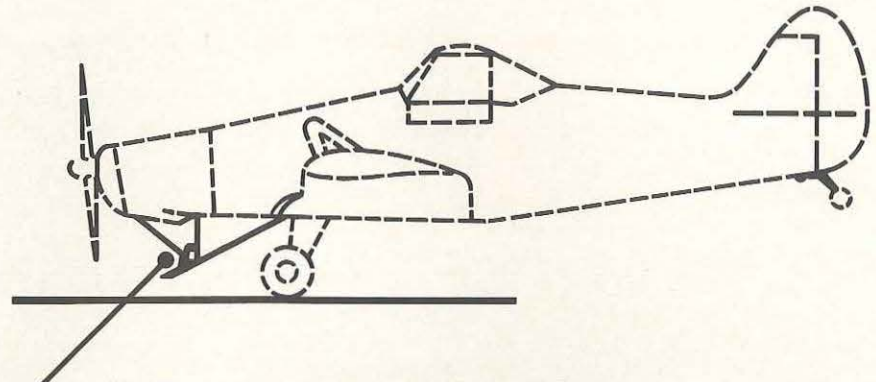
However, when he descended to recommence spraying, having been distracted by his problems, he forgot about a single-strand power line which was across his path until he had almost collided with it. His attempt to evade the wire failed and it snagged the rudder horn leading edge, tearing off the horn and the rudder section above the top hinge. Fortunately, aircraft controllability was retained and the pilot was able to fly his damaged aircraft to the nearest suitable aerodrome and land safely.

## Summary

It is well understood that aerial application is an extremely demanding exercise. As the major articles referred to concluded, continued safe operations largely boil down to 'establishing a personal set of safety rules *and disciplining oneself to adhere to them at all times*'. That many agricultural pilots have flown for many years and thousands of hours without having a wire strike shows that it can be done, and emphasises the efficacy of the simple but fundamental dictum quoted above ●

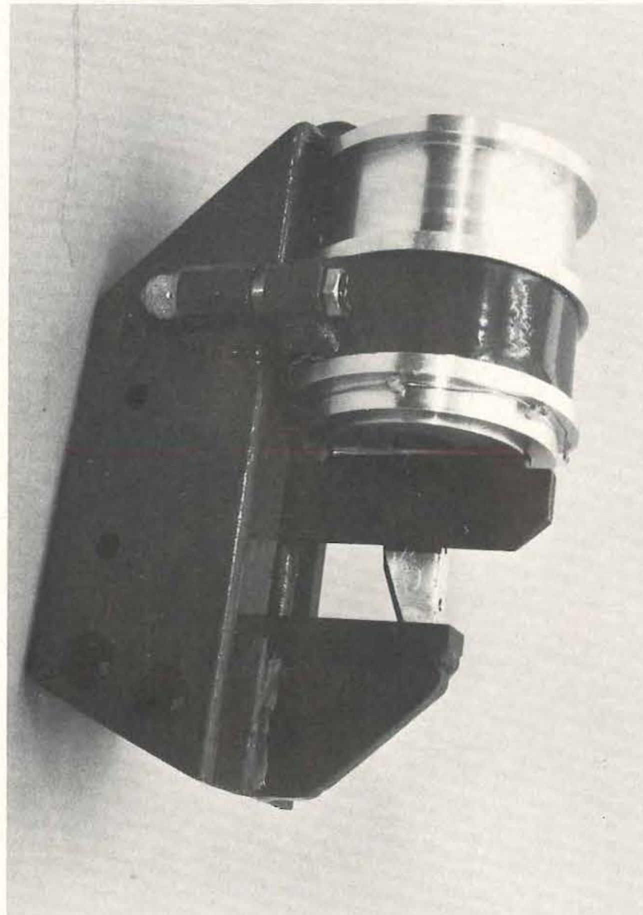


# Cable cutter for agricultural aircraft



**Cable cutter on mounting installation**

Accident statistics show that strikes of electricity distribution cables by fixed wing aircraft constitute a significant proportion of agricultural aircraft accidents. Strikes above the propeller spinner are not usually catastrophic: the aircraft remains in most cases controllable. This is not so with strikes occurring below the thrust line, because cables hook onto the landing gear, slow the aircraft below flying speed and cause it to nose dive into the ground.



For some years, the Department of Aviation, in conjunction with other Government organisations, has been developing a device to cut cables, particularly those which strike below the spinner.

The operating principles of the cutter are as follows — after the first cable is gathered and guided to the cutter opening:

- it actuates a trigger which fires an igniter unit and small propellent charge located on the top of a piston within the actuator cylinder;
- this generates gases which cause the piston to overcome the resistance of preset shear pins and to move downwards;
- the bottom face of the piston is fitted with a wedge-shaped hardened steel blade which cuts the cable (or cables) against a steel anvil.

The igniter unit includes a pyrotechnic delay, the purpose of which is to allow the time for up to three cables of a distribution line to enter the jaws before cutting. It is sufficiently small (0.15 sec) as to be insignificant from the point of view of the aircraft retardation.

Other features of the design are its complete independence from the aircraft electric power supply and the fact that combustion products are completely contained within the combustion chamber during and after actuation, so as not to present a risk of starting a post-crash fire.

The device has been fully proven by a series of field trials with the cutter mounted on a truck and a trial installation has been flown on a Piper Pawnee. The only continuing work is vibration testing to prove the durability of the propellent. The design is protected by patent in Australia, New Zealand and the USA, but it is not the Department's intention to manufacture or market it. The design has been made available to the Aerial Agricultural Association of Australia with a view to batch production, but this has not eventuated as yet. It is regrettable to see a device of much merit languish for lack of interest among those most likely to benefit ●

# Planning a spray run

A Hiller UH-12E was being used to spray fungicide on a wheat crop. The wind was from the south-west at about 5 knots. A south-east to north-west spray run was being used, tracking to the north over ground which descended for approximately half of the run and then ascended over the remainder (see Figure 1).

A twin-cable power line ran adjacent to the northern boundary of the area: the last spray run was planned to pass beneath the line at a shallow angle of 15 degrees about half way along the run.

After passing beneath the power lines the aircraft drifted to the left of the planned spray track and remained beneath the lines as it ascended the rising ground. The pilot attempted to correct the left drift by applying right pedal but the aircraft still tracked beneath the lines.

Approaching the trees and shed shown in the photograph, the pilot applied aft cyclic to stop the aircraft. However, the main rotor struck the power lines, cutting both cables. The helicopter rotated to the right and struck a tree, severing the tail boom. It then rolled onto the ground and came to rest facing the north-west.

### Analysis

An analysis of this occurrence reveals that the pilot's planning and conduct of the spray run was an important factor in the accident.

Because of the way in which the spray run was planned, the principal obstacles (twin 3/12 inch steel power cables) were crossed at a shallow angle, thereby increasing the time interval that the helicopter remained in close proximity to them. Ideally, such obstacles should be crossed at a right angle, or at least an obtuse angle.

Further obstacles in the form of trees, a house and a shed were located adjacent to the end of the planned spray run. As shown in the photograph these obstacles effectively blocked the only track available once the aircraft had drifted beneath the wires on the final section of the spray run.

The wind, a light south-westerly, would have tended to drift the helicopter towards the power lines once it had passed beneath them and commenced the upslope section of the spray run. Any reduction in forward speed while ascending the upslope would have increased this drift effect.

During the latter section of the spray run the pilot was very conscious of the proximity of the wires on his left. This distraction, which occurred during the normal high workload of the swath run, would have diverted his attention to some degree from that normally paid to maintaining track alignment towards the flagman.

Faced with the approaching obstacles in the form of the trees, house and shed, and the narrowing gap between the ground and wires, the pilot attempted to pull up to prevent collision with these obstacles. The resultant tilting of the tip path plane of the main rotors brought them into contact with the power lines immediately above.

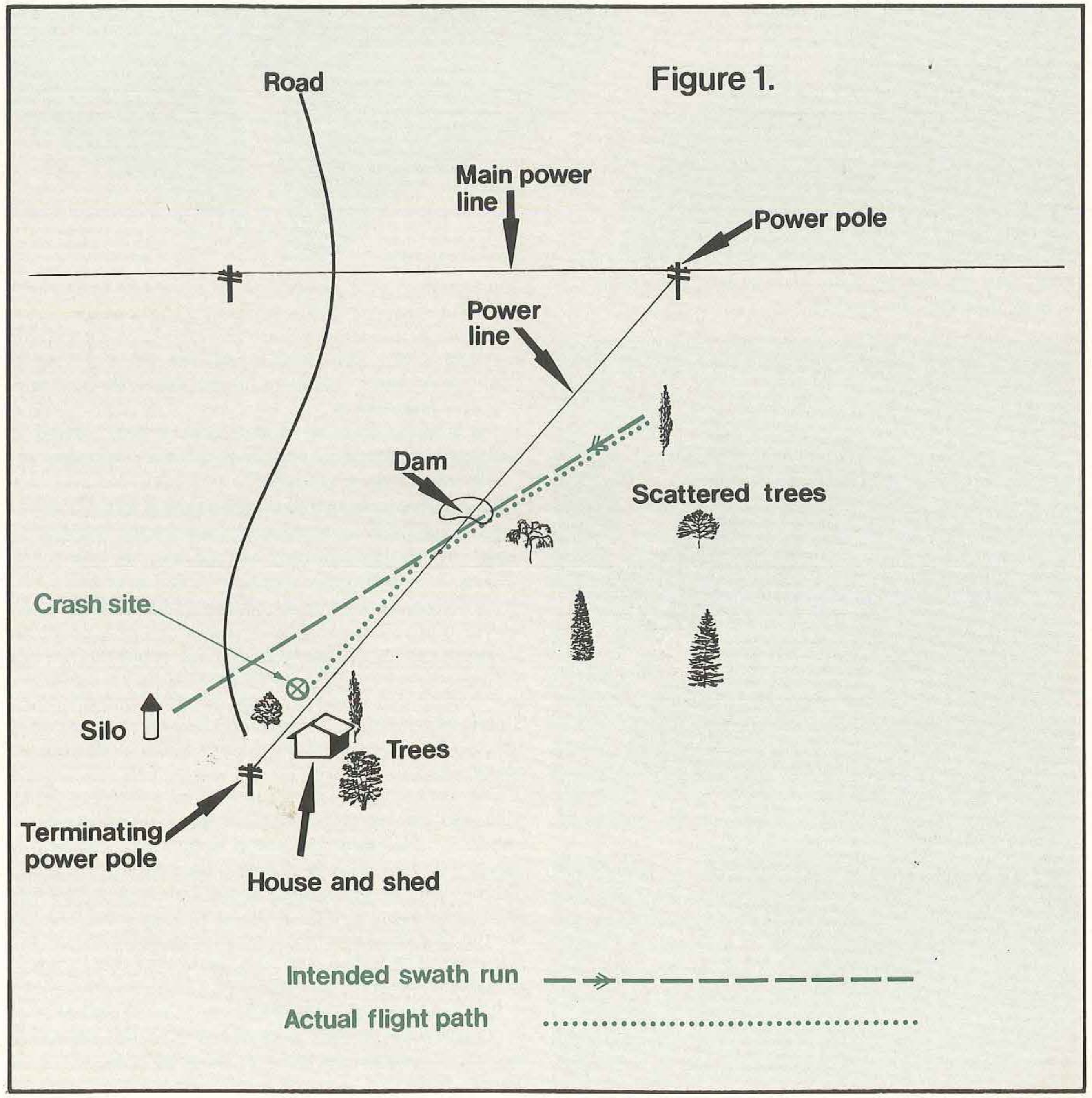


Figure 1.

### Relevant factors

The following factors relevant to this accident were identified by the BASI investigator:

- inadequate pre-flight planning
- failed to properly appreciate and did not take timely action to avoid an increasingly hazardous situation
- misjudged vertical clearance from obstacles
- obstacles — power lines, trees, house and shed
- terrain — rising ground on latter section of the spray run, progressively limiting clearance from the power lines
- pilot relatively inexperienced in agricultural spraying operations — inadequate training in:
  a. analysis of wind direction and strength in the operating area/relationship with field layout; and
  b. assessment of wire runs and problems associated with treatment areas and wires.

### Comment

Given the operating conditions, a safer course of action would have been that of terminating the spray runs earlier, and passing under the wires at an obtuse angle. This would have prevented the pilot from becoming trapped in what was, in effect, a tunnel formed by the rising ground and overhead wires and which was blocked by the trees, house, garage and power pole.

The area near the house could then have been cleaned up by short runs almost at 90 degrees to the power lines, and parallel to the obstructions of the house etc. (see Figure 2). *Continued overleaf.*

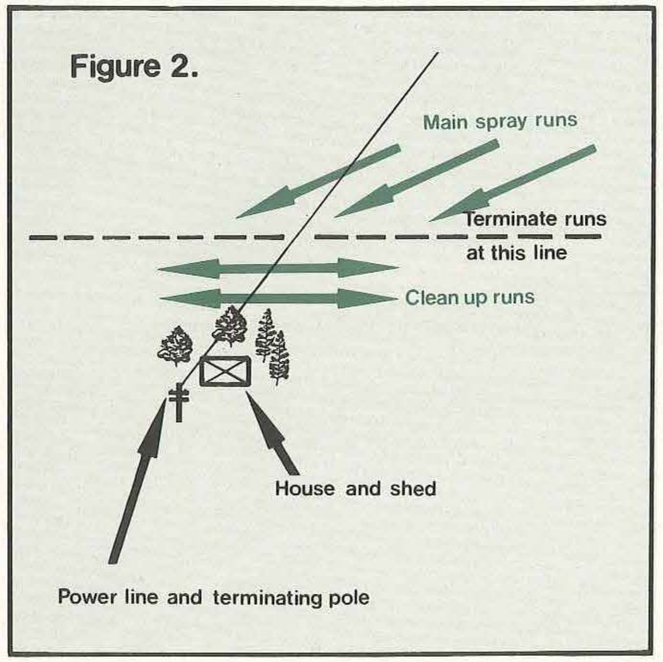


Figure 2.

## Planning a spray run *(continued)*

### Clean-up runs

Clean-up runs, because of their very nature, can often involve difficult terrain. Because of this it may be preferable in some circumstances to complete clean-up runs first, while you are still at your freshest and most alert, and before heat and turbulence make conditions more difficult. If clean-up runs are done last, an extra hazard check before commencement can be worthwhile.

### Conclusion

Obviously the possibilities for planning application runs are infinite. Nevertheless, certain sound practices must always be observed. The key to safety in this regard is to consider those practices with the greatest care during preflight planning. In regard to this, supervisors and pilots must always appreciate the value of experience ●



# The ICAO safety guide to agricultural aviation operations

By their very nature, agricultural aviation operations are potentially hazardous. However, there is evidence that such operations can be safely performed provided:

1. The pilot and other essential flight crew members have been specifically selected and trained for this type of work.
2. The pilot and crew abide by common sense personal practices on such matters as food and drink; including alcohol, smoking, drugs, self-administered or otherwise; hygiene; and mental discipline.
3. The aircraft used has been specially designed or specifically modified by a competent authority to perform the task.
4. The airstrip used conforms to minimum safety standards. It should be chosen and prepared so as to allow safe operations to be conducted under all foreseeable conditions under which the task is likely to be performed. It should provide means of enabling the pilot to determine the surface wind direction and approximate speed.
5. The structural limitations of the aircraft are known and are taken into account and all practical steps are taken to ensure that the aircraft is maintained in an airworthy condition.
6. The physical limitations of the pilot and crew are assessed and taken into account and a watch is kept by the pilot himself as well as by others for early symptoms of fatigue.
7. Correctly fitting, well-maintained protective helmet, clothing, and safety harness are used at all times by the pilot and crew.
8. A knowledge of all local obstacles, such as wires and cables, is ascertained beforehand and thereafter taken into account.
9. The local meteorological conditions likely to be encountered are studied and taken into account.
10. Essential aircraft operating data are ascertained and taken into account, including knowledge of the centre of gravity limits; loading take-off and landing limitations; and stall characteristics under all foreseeable flight conditions.
11. Where chemicals are used, a prior study is made both of their toxic characteristics and of the means by which these may be absorbed into the body, which is thereafter taken into account by all personnel likely to come into contact with this substance ●