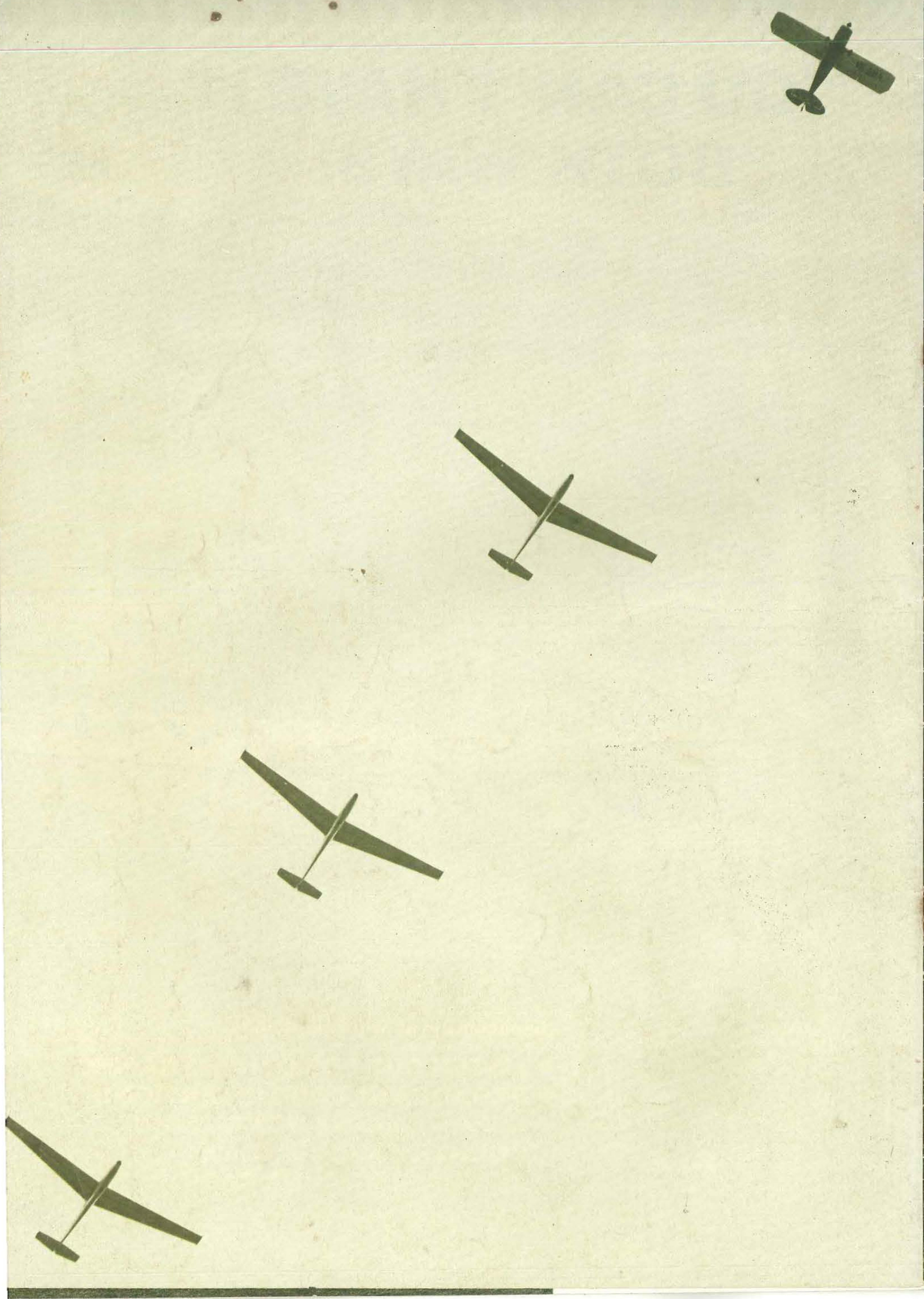
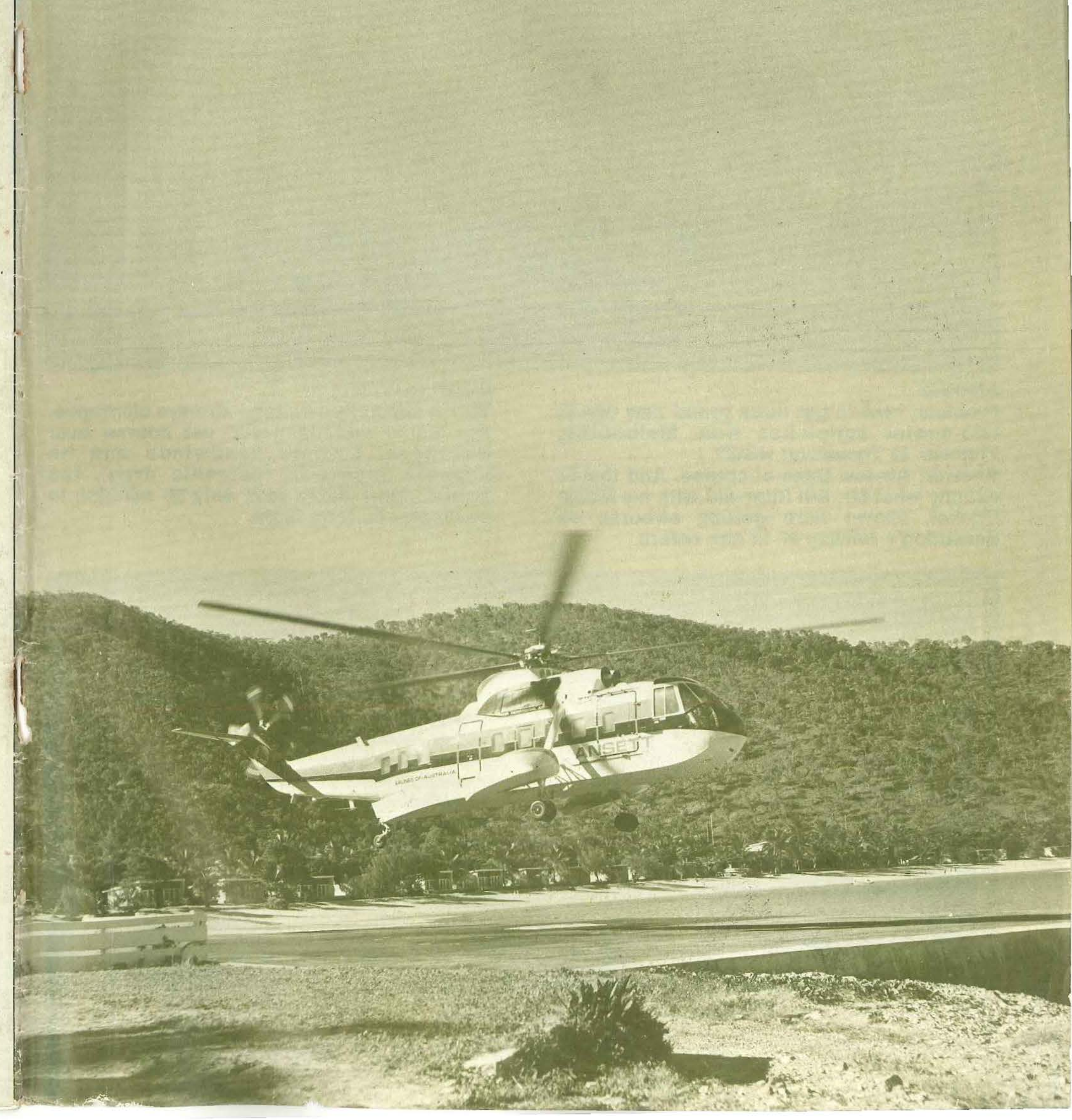


AUSTRALIAN DEPARTMENT OF TRANSPORT

Number 98 1977

AVIATION SAFETY DIGEST



ABOVE:
Problem: How to get three brand-new Blanik two-seater sailplanes from Melbourne, Victoria, to Tocumwal NSW?
Answer: Air-tow them of course. And that is exactly what Mr. Bill Riley did with his Maule Rocket, shown here getting airborne on Essendon's runway 27 in line astern.

REAR COVER:
With a specially arranged airways clearance, the Maule and its 'train' set course over Essendon. Despite headwinds and its unusual degree of 'parasitic drag', the hardworking Maule took only 90 minutes to complete the ferry flight.

One of Ansett Airlines of Australia's two Sikorsky S61N helicopters takes off from the heliport at Hayman Island, Queensland on the frequent scheduled service which the company operates between Proserpine and the islands of the Whitsunday Passage.
Facilitating a degree of access to the islands that would have been unthinkable not many years ago, the 28-passenger helicopters have won themselves an almost indispensable role in the Great Barrier Reef tourist industry. Their operation forms a major part of the growing volume of aviation activity linking the Queensland coast islands with the mainland.
The helicopters are IFR equipped and it is intended that all-weather operations will be introduced in the near future.

PRIVATE PILOTS AND PROFESSIONALISM

The latest Australian air safety statistics, contained in the Department's Survey of Accidents for 1975 released earlier this year, show a heartening improvement in the accident rate in general aviation for that year.

Not only was there a substantial reduction in the total number of accidents by comparison with previous years, but the fatal accident rate dropped to the all-time low of .99 per 100 000 hours flown, a figure twenty per cent better than any previous year and less than half that of ten years ago. And all this despite a steady increase in total hours flown and the number of aircraft on the Australian register!

Having said this however, it remains true that the sector responsible for the greatest number of hours in general aviation — Private and Business flying — is still the one in which there remains the most room for improvement. For with the exception of the figures for Agricultural flying, which reflect to some extent the 'occupational hazard' inherent in that type of work, Private and Business flying, though improved, continues to claim both the highest overall accident rate, and the worst rate for fatal accidents. Furthermore, while preliminary statistics now available for 1976 indicate that the accident rates for the commercial flying sectors generally have continued to improve, those for Private and Business flying have regressed.

There is nothing in the nature of Private and Business flying that should make it any more accident prone than the remaining three categories of general aviation operations — Charter-Commuter, Flying Training and Other Aerial Work — all of which have achieved commendably low accident rates. So much so in fact that the latter two categories distinguished themselves in 1975 by completing the whole year's operations without a single fatality in either case. But perhaps the real significance of the anomaly in these general aviation figures is brought out when it is seen that, for the Private and Business Flying sector, the circumstances in nearly every accident point to a failure of airmanship rather than of aircraft.

It has been said before that nowhere else in aviation does the responsibility for the safety of his operation devolve more personally than on the private pilot operating quite independently of any form of supervision. For this reason it is essential that he develop the capacity for objective self-appraisal and self-discipline. Only in this way can he hope to attain a level of airmanship comparable with the standard of those who earn their livelihood in the air and whose professional standards are a way of life.

Obviously the private pilot who only flies occasionally cannot hope to achieve and maintain the manipulative and procedural competence of the full-time professional. But in at least one respect his airmanship can be every bit as professional — knowing and recognising his limitations. The pilot who has a realistic estimate of his own capabilities, whether they be great or small, and who consistently flies within those limits, is the pilot who should be around for a long time.

The magazine 'Flight International', concerned with a similar situation in British general aviation, puts it this way: 'Don't fly beyond your limitations, especially into poor weather, or into what may turn out to be poor weather. Main lessons:—

- Time spent on weather reports, and on planning diversions even when the weather forecast looks good, is time well spent.
- If there is any doubt about the weather and your instrument capability in sudden poor visibility, don't depart.
- Do your checks punctiliously.
- Consider the effect of temperature on performance and watch the weight of suitcases and where you put them.
- Don't touch alcohol for at least eight hours and preferably longer before flying.
- If you are seriously lost don't hesitate to declare an emergency.
- Watch safety heights enroute — spend the previous evening on the topography, including routes to contingency diversions.
- Have a proficiency check every six months without fail.
- Listen to and seek the advice of more experienced pilots. The mature pilot, whether he has 100 or 10 000 hours, is the one who knows his limitations.'

And that's good advice for us all!

AVIATION SAFETY DIGEST

Number 98 1977

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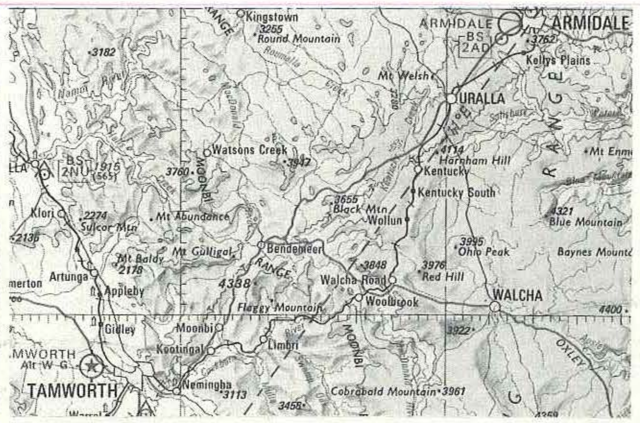
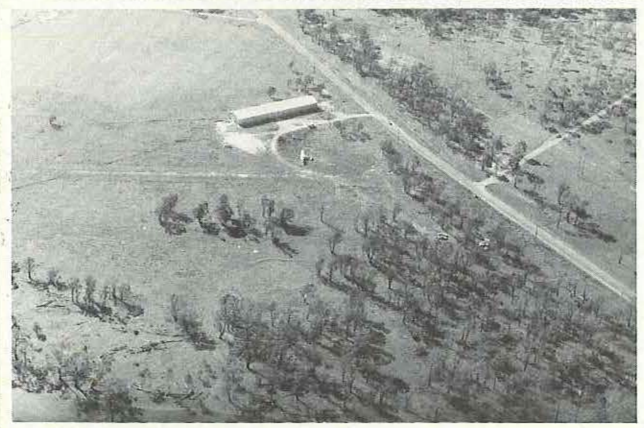
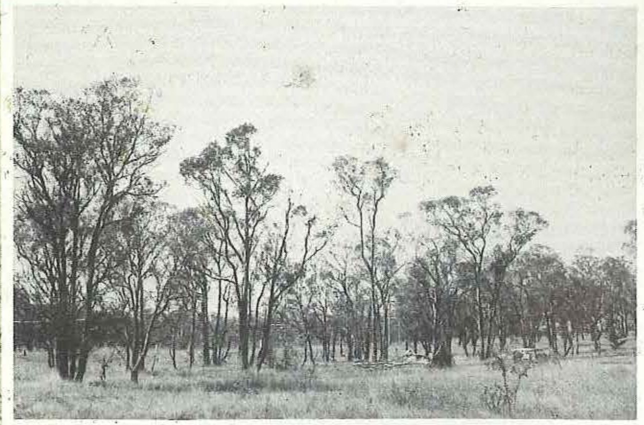






TOO LATE TO RECONSIDER.

It can take only one mistake to bring about a fatal accident. Yet often that error is but the final misjudgement in a whole series of lesser ill-timed decisions which one by one have contrived to set the scene for the final disastrous outcome. Just such a train of unfortunate events occurred recently in New South Wales, and ended in tragedy for three people.

A private pilot, with just over 200 hours experience, had planned a return flight from Archerfield, Queensland, to Bankstown, NSW, and had arranged to take two passengers as far as Cessnock where they would stay while the pilot continued to Bankstown. For the flight, the pilot hired a Piper PA-28-140, a type on which he had only ten hours experience, though he had flown nearly forty-five hours on more powerful types of Cherokee aircraft. The pilot was not instrument rated, though he had begun training for a Night VMC rating. The trip to Sydney via the coast and Cessnock was entirely uneventful, and the pilot landed at Bankstown as planned late on a Friday afternoon.

In readiness for the return flight the pilot arrived at the airport the following Monday morning at about 1100 hours and refuelled the aircraft. He then obtained the forecasts for the areas through which he would be flying. Some coastal and inland cloud was predicted at 4000 to 5000 feet with isolated showers. After obtaining the forecast, he made out his flight plan and submitted it to the Briefing Office. His intention was to proceed VFR via Cessnock, where he would again pick up his passengers, and from there direct to Armidale, then via Tenterfield to Archerfield.

The flight as far as Cessnock was again without incident, and the pilot landed at about noon. While waiting for his passengers he refuelled the aircraft again, adding about 27 litres. The passengers arrived soon after 1300 hours and he assisted them into the aircraft. One passenger sat in the back, and the other, a child, sat next to the pilot in the right hand seat. They took off from Cessnock at 1318 hours.

Much of the direct track from Cessnock to Armidale lies over part of the Great Dividing Range, with mountains rising to 5000 feet. There are few roads or other clear landmarks on track but the pilot had planned to fix his position by reference to the Liddell Power Station, though it would be well to the west, and then to intercept the railway line between Tamworth and Armidale. If he missed the railway line he believed he would have no difficulty in locating the Walcha road, which would lead him to the railway.

As the flight from Cessnock proceeded however, the cloud became thicker than the pilot had expected and from time to time he was forced to divert to the west. He sighted the Barnard River, which was on his planned track, and the small town of Niangala. But the cloud continued to increase, and his diversions became more frequent.

The pilot called Coff's Harbour Flight Service, revising his ETA Armidale, but a short time after this ETA had passed he was forced to call again and report that he was having difficulty remaining in Visual Meteorological Conditions. When Coff's Harbour asked for his position, he admitted that he was now uncertain.

Conditions at Coff's Harbour and along the coast were now below VMC, so that the aircraft could not be directed to fly east. The Flight Service Unit declared an Alert Phase, and Brisbane Air Traffic Control was asked if the lost aircraft was painting on radar. The aircraft was not transponder equipped, and the radar could not locate it.

By this time the pilot had reported sighting a main road, which he was keeping in sight, believing his position to be to the west of Armidale. At this stage the aircraft still had an endurance of almost four hours and the pilot was asked to hold position while efforts were made to determine the aircraft's location. Coff's Harbour then passed the pilot advice from a high flying aircraft that the weather was better to the west, and advised him to divert to Tamworth on a heading of 220 degrees.

Another aircraft, a Beech 35, was operating in the area on an IFR flight from Tamworth to Armidale and as its pilot was based at Armidale, he was asked to contact the lost Cherokee direct, to try to help the pilot determine his position. The pilot of the Cherokee had now arrived over a town, which he described to the Beech pilot. From this description, the Beech pilot thought that the town could possibly be Walcha, though he could not be certain.

The Cherokee pilot, after overflying the town, had located an airstrip. The weather in the area was still unfavourable and as he was still unsure of the identity of the town, he decided he would land to positively determine his position. He had identified the strip as a sloping agricultural strip, but seemed confident of his ability to make a successful landing. There was an agricultural aircraft on the ground, which the pilot took as an indication that the strip was serviceable.

The pilot overflew the strip, but could see no windsock or other indication of the direction of the wind. However, he assumed that the wind was blowing down the strip and believed he would be landing both uphill and into wind. He flew a circuit at about 1000 feet above ground level, and during his pre-landing drill checked to see that the passengers' seat harnesses were fastened.

The pilot made a long downwind leg, with a short base and fairly long final, aiming to approach 'low and slow'. He could not subsequently recall his airspeed on final but thought it was about 80 knots after he had extended three notches of flap. The aircraft apparently touched down well into the strip, and the pilot suddenly realised how quickly the aircraft was approaching the trees at the far end of the strip and that he could not possibly stop before he reached them. The aircraft was still travelling at about 60 knots so the pilot decided to go around. He applied full throttle, but did not have time to raise the flaps, so they remained down in the three notches position.

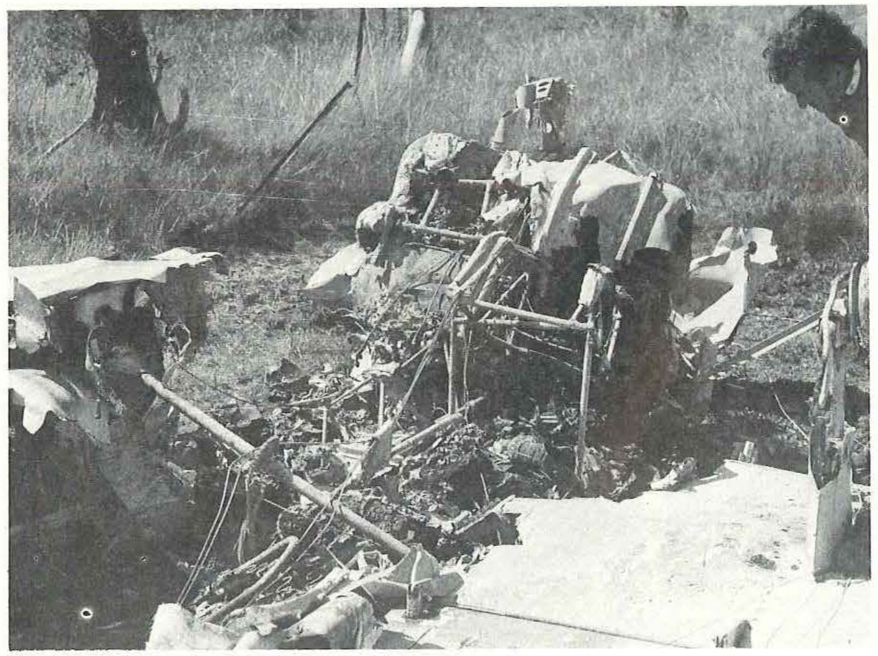
The aircraft responded by climbing but at this point it was getting perilously close to the trees and the pilot began a turn to the right to try to avoid one of the taller trees. While banked at an angle of about 45 degrees however, the starboard wing struck a tree at a height of about 40 feet. The aircraft then collided with other trees, and finally struck the ground in a steep nose down attitude coming to rest upside down. The nearly full starboard fuel tank burst, and a fierce fire broke out.

When witnesses reached the scene of the accident, the pilot was lying on the ground outside the aircraft, with severe burns and a broken leg. The passengers had not escaped from the burning aircraft, and had died in the fire.

* * * * *

In looking at the events that led up to this tragedy, it is clear that the pilot, who had only limited experience, had been led step by step by circumstances to place himself and his passengers in a dangerous and eventually fatal situation.

His original decision to track direct from Cessnock to Armidale over a formidable stretch of mountainous country with few clearly recognizable landmarks was unwise.



Navigation would have been much easier if he tracked further inland via a number of towns and roads. In addition, the forecast cloud should have warned him that visibility was likely to be difficult over the mountains. His action in pressing on even after encountering cloud problems was almost sure to contribute to his navigational difficulties. Once lost however, he acted correctly in calling for assistance, and he may well have been able to complete the flight safely by diverting to Tamworth. Yet, once he had sighted the agricultural strip, he apparently became convinced that it was important for him to land as soon as possible. This decision was certainly his to make, but the pilot had never before landed on a one-way agricultural strip. The strip was only 657 metres long and, at a height of 3700 feet above sea level, was a good deal higher than any other strip at which the pilot had operated. There is no doubt that the aircraft could have made a safe landing on the strip in the prevailing conditions, but the pilot misjudged both the wind conditions and his approach to the strip.

The wind, rather than blowing down the strip as the pilot had thought, was evidently a tailwind of moderate strength. Calculations have shown that in this aircraft on such a short strip, the decision to go around from a missed approach would have to be made very early to clear the obstacles at the far end.

In persisting with a misjudged approach the pilot placed the aircraft in a position in which an accident of some sort was virtually inevitable. Contributing factors in the accident included the lowered performance of the aircraft at such an altitude and the fact that the pilot's experience had been largely on more powerful Cherokee types.

Standards for agricultural strips are lower than those for private operations, and agricultural pilots are trained to cope with these limitations. In the case of this strip the normal requirement for an obstacle-free gradient at both ends of the strip was not met and the overall strip had a slope of about 1 in 40. It is not clear whether at the time of the accident the pilot was aware of the differences between agricultural strips and those authorised for private operations. In any case the landing that he decided to make was almost certainly only to establish his location, rather than being a genuine emergency in which he would have had no choice but to land.

The cause of the accident was that: 'The pilot, having misjudged the landing approach, did not initiate a go-around at a sufficiently early time'. But this brief summary, while perfectly true, does not indicate that the tragedy had its real beginnings much earlier, in the chain of events that seems to have resulted from the pilot's decision to fly a difficult leg in very doubtful conditions.

HOW TO AVOID A MID~AIR COLLISION

(Reprinted with acknowledgment to AOPA Air Safety Foundation, USA)

Photograph courtesy of FAA 'General Aviation News'

By definition and function, the human eye is one of the most important and complex systems in the world. Basically, its job is to accept images from the outside world and transmit them to the brain for recognition and storage. In other words, the organ of vision is our primary means of identifying and relating to what's going on around us.

It has been estimated that 80 per cent of our total information intake is through the eyes. In the air we depend on our eyes to provide most of the basic input necessary for flight — attitude, speed, direction, proximity to things, and opposing air traffic that may constitute a danger of in-flight collision. As traffic density and aircraft closing speeds increase, the problem of in-flight collision grows proportionately, and so does the importance of the 'eyeball system'. A basic understanding of the eyes' limitations in target detection is probably the best insurance of all against running into another aircraft.

The eye, and consequently vision, is vulnerable to just about everything: dust; fatigue; emotion; germs; fallen eyelashes; age; optical illusions; and the alcoholic content of last night's party. In flight our vision is altered by atmospheric conditions, windshield distortion, too much oxygen or too little, acceleration, glare, heat, lighting, aircraft design and so forth.

Most of all, the eye is vulnerable to the vagaries of the mind. We can 'see' and identify only what the mind lets us see. For example, a daydreaming pilot staring into space sees no approaching traffic and is probably the No. 1 candidate for an in-flight collision.

One function of the eye that is a constant problem to the pilot (though he is probably never aware of it) is the time required for accommodation. Our eyes automatically accommodate for near and far objects. But the change from something up close, like a dark panel two feet away, to a well-lighted landmark or aircraft target a mile or so away, takes one to two seconds, or longer. That can be a long time considering that you need 10 seconds to avoid an in-flight collision.

Another focusing problem usually occurs at very high altitudes, but can also happen at lower levels on vague, colorless days above a haze or cloud layer when no distinct horizon is visible. If there is little or nothing to focus on at infinity, we do not focus at all. We experience something known as 'empty-field myopia'; we stare but see nothing, even opposing traffic, if it should enter our visual field.

The effects of what is called 'binocular vision' have been studied by the National Transportation Safety Board during investigations of in-flight collisions, with the conclusion that this is also a causal factor. To actually accept what we see, we need to receive cues from both eyes. If an object is visible to one eye, but hidden from the other by a windshield post or other obstruction, the total image is blurred and not always acceptable to the mind.

Another inherent eye problem is our narrow field of vision. Although our eyes accept light rays from an arc of nearly 200° they are limited to a relatively narrow area (approximately 10-15°) in which they can actually focus on and classify an object. Though we can perceive movement in the periphery, we cannot identify what is happening out there, and we tend not to believe what we see out of the corner of our eyes. This, aided by the brain, often leads to 'tunnel vision'.

This limitation is compounded by the fact that at a distance, an aircraft on a collision course will appear to be motionless. It will remain in a seemingly stationary position, without appearing either to move or to grow in size for a relatively long time, then suddenly bloom into a huge mass filling the whole window. This is known as 'blossom effect'. Since we need motion or contrast to attract our eyes' attention, this becomes a frightening factor when we realise that a smear or dirty spot on the windscreen can hide a converging aircraft until it's too close to be avoided.

In addition to the built-in problems, the eye is also severely limited by environment. Optical properties of the atmosphere alter the appearance of traffic, particularly on hazy days. 'Limited visibility' actually means 'limited vision'. You may be legally VFR when you have six kilometres, but at that distance on a hazy day, opposing traffic is not easy to detect. At a range closer than six kilometres — even though detectable — IT MAY NOT BE AVOIDABLE.

Lighting also affects our vision stimuli. Glare, usually worse on a sunny day over a cloud deck or during flight directly into the sun, makes objects hard to see and scanning uncomfortable. Also, an object that is well lighted will have a high degree of contrast and will be easy to detect while one with low contrast at the same distance may be impossible to see. For instance, when the sun is behind you, an opposing aircraft will stand out clearly, but when you're looking into the sun and your traffic is 'backlighted', it's a different story.

Another contrast problem is trying to find an aircraft over a cluttered background. If it is between you and terrain that is vari-coloured or heavily dotted with buildings, it will blend into the background until it is quite close.

And, of course, there is the mind, which can distract us to the point of not seeing anything at all, or lull us into cockpit myopia — staring at one instrument without even 'seeing' it.

Visual perception is thus affected by many factors. Pilots, like anyone else, tend to overestimate their visual abilities and to misunderstand their eyes' limitations. Since the No. 1 cause of in-flight collisions is the failure to properly adhere to the see-and-be-seen concept, we can conclude that the best way to avoid them is to learn how to use our eyes in an efficient external scan.

How to Scan

The most important thing is for each pilot to develop a scan that is both comfortable and workable for him . . . in his own aircraft.

The best way to start is by getting rid of bad habits. Naturally, not looking out at all is the poorest scan technique, but glancing out at intervals of five minutes or so is also poor when you remember that it only takes seconds for a disaster to happen. Check yourself the next time you're climbing out, making an approach, or just bouncing along over a long cross-country route. See how long you go without looking out the window.

Glancing out and giving it the old once-around without stopping to focus on anything is practically useless; so is staring out into one spot for long periods of time.

So much for the bad habits. Learn how to scan properly; first, by knowing where to concentrate your search. It would be preferable, naturally, to look everywhere constantly but, that not being practical, concentrate on the areas most critical to you at any given time. In the traffic pattern especially, clear yourself before every turn, and always watch for traffic making an improper entry into the pattern. On descent and climb-out, make gentle S-turns to see if anyone is in your way. Make clearing turns, too, before attempting manoeuvres.

During that very critical final approach stage, don't forget to look behind and below, at least once; and avoid tunnel vision. Pilots often rivet their eyes to the point of touchdown. You may never arrive at it if another pilot is aiming for the same numbers at the same time.

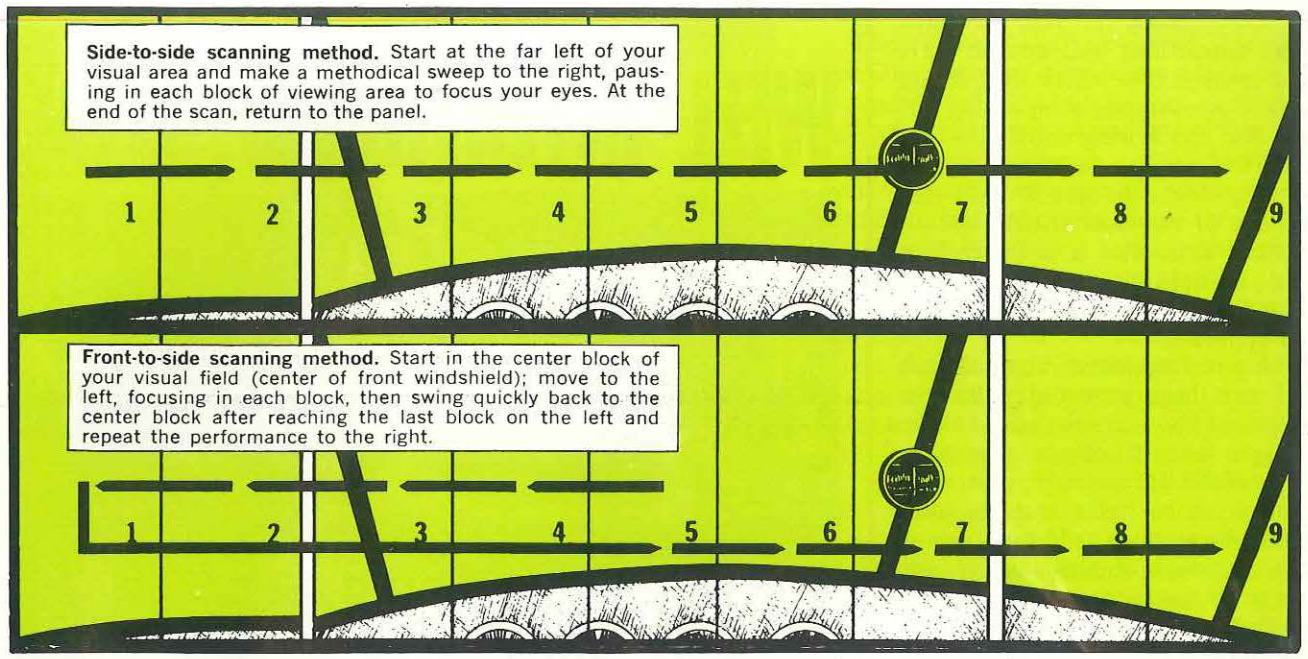
In normal flight, you can generally avoid the threat of an in-flight collision by scanning an area 60° to the left and to the right of your centre visual area. This doesn't mean you should forget the rest of the area you can see from your side windows every few scans. Horizontally, the statisticians say, you will be safe if you scan 10° up and down from your flight vector. This will allow you to spot any aircraft that is at an altitude that might prove hazardous to your own flight path, whether it's level with you, below and climbing, or above and descending.

The slower your plane, the greater your vulnerability; hence, the greater scan area required.

But don't forget that your eyes are subject to optical illusions and can play some nasty tricks on you. At one mile, for example, an aircraft flying below your altitude will appear to be above you. As it nears, it will seem to descend and go through your level, yet, all the while it will be straight and level below you. One in-flight collision occurred when a pilot experienced this illusion and dived his aircraft right into the path of the one flying below him.

Though you may not have much time to avoid another aircraft in your vicinity, use your head when making defensive moves. Even if you must manoeuvre to avoid a real in-flight collision, consider all the facts. If you miss the other aircraft but stall at a low altitude, the results may be the same for you.

Aircraft are more difficult to see against a cluttered city background.



Scan Patterns

Your best defence against in-flight collisions is an efficient scan pattern. Two basic scans that have proved best for most pilots are called the 'block' system. This type of scan is based on the theory that traffic detection can be made only through a series of eye fixations at different points in space. Each of these fixes becomes the focal point of your field of vision (a block 10-15° wide). By fixating every 10 to 15°, you should be able to detect any contrasting or moving object in each block. This gives you nine to 12 'blocks' in your scan area, each requiring a minimum of one to two seconds for accommodation and detection.

One method of block scan is the 'side-to-side' motion. Start at the far left of your visual area and make a methodical sweep to the right, pausing in each block to focus. At the end of the scan, return to the panel.

The second form is the 'front-to-side' version. Start with a fixation in the centre block of your visual field in front. Move your eyes to the left, focusing in each block, swing quickly back to the centre block, and repeat the performance to the right.

There are other methods of scanning, of course, some of which may be as effective for you as the two preceding types. But unless some series of fixations is made, there is little likelihood that you will be able to detect all targets in your scan area. When the head is in motion, vision is blurred and the mind will not register targets as such.

The Time-Sharing Plan

External scanning is just part of the pilot's total eyeball job. To achieve maximum efficiency in flight, one has to establish a good instrument panel scan as well and learn to give each its proper share of time. The amount of time one spends looking outside the cockpit in relation to what is spent inside depends, to some extent, on the workload inside the cockpit and the density of traffic outside. Generally, the external scan will take about three to four times as long as a look-around the instrument panel.

Panel Scan

An efficient instrument scan is good practice, even if you limit your flying to VFR conditions, and being able to quickly scan the panel gives a better chance of doing an effective job outside as well.

Start with the attitude indicator. It will show changes in attitude affecting the two most critical areas of flight — heading and altitude. Move to the directional gyro for heading; to altimeter; airspeed indicator; rate of climb; and turn and bank. It is a good idea to skim over the attitude indicator each time you move on to a new instrument as this is your chief control instrument. Include your VOR and engine instruments every third scan or so, or as the flight situation dictates.

Developing an efficient time-sharing plan takes a lot of work and practice, but is just as important as developing good landing techniques. The best way is to start on the ground, in the aeroplane you usually fly, and then use your scans in actual practice every chance you get.

Collision Avoidance Checklist

Collision avoidance involves much more than proper eye techniques. You can be the most conscientious scanner in the world and still have an in-flight collision if you neglect other important factors in the overall see-and-be-seen picture. It might be helpful to use a collision avoidance checklist as religiously as you do the pre-takeoff and landing lists. Such a checklist might include the following nine items.

1. Check yourself. Start with yourself. Your eyesight, and consequently your safety, depend on your mental and physical condition.

2. Plan ahead. Have charts folded in proper sequence and within handy reach. Keep your cockpit free of clutter. Be familiar with headings, frequencies, distances, etc., so that you spend the minimum time with your head down.

3. Clean windows. During the pre-flight inspection, make sure your windscreen is clean. If possible, keep all windows clear of obstructions, like solid sun visors and curtains.

4. Adhere to correct operating procedures and observe regulations such as correct altitudes and proper circuit patterns. You can get into trouble, for instance, by 'sneaking' out of your proper altitude as cumulus clouds begin to tower higher and higher below you, or by skimming along the tops of clouds without observing proper separation. Some typical situations involving inflight conflictions around airports include: entering a right-hand pattern at an airport with left-hand traffic; entering downwind so far ahead of the traffic pattern that you may interfere with traffic taking off and heading out in your direction.

5. Avoid crowded airspace enroute, such as directly over a radio aid. You can navigate on VFR days just as accurately by passing slightly to the left or right of the aid. Pass over airports at a safe altitude.

6. Compensate for your aircraft's design limitations. All aircraft have blind spots; know where they are in yours. For example, a high-wing aircraft that has a wing down in a turn blocks the area you are turning into. A low wing blocks the area beneath you. And one of the most critical mid-air potential situations is a faster low-wing aeroplane overtaking and descending on to a high wing during final approach.

7. Equip for safety. Your aircraft itself can help to avoid collisions. Equipment that was once priced above the light aircraft owner's reach is now available at reasonable cost. High intensity strobe lights increase your contrast by as much as 10 times day or night. In areas of high density, use your strobes or your rotating beacon constantly, even during daylight hours. Transponders, now available in quick installation kits, significantly increase your safety by allowing radar controllers to keep traffic away from you and vice versa.

8. Talk and listen. Use your radios, as well as your eyes. Detecting a tiny aircraft at a distance is not the easiest thing to do, so make use of any hints you get over the radio. A pilot reporting his position to a tower is also reporting to you. And your job is much easier when an air traffic controller tells you your traffic is 'three miles at one o'clock'. Once you have that particular traffic, by the way, don't forget the rest of the sky. If the traffic seems to be moving you're not on a collision course, so continue your scan and watch it from time to time. If it doesn't appear to have motion, however, we suggest you watch it very carefully, and get out of its way.

9. Scan! The most important part of your checklist, of course, is to keep looking where you're going and to watch for traffic. Make use of your scan constantly.

Basically, if you adhere to good airmanship, keep yourself and your aeroplane in good condition, and develop an effective scan time-sharing system, you'll have no trouble avoiding in-flight collisions. And as you learn to use your eyes properly, you'll benefit in other ways. Remember, despite their limitations, your eyes provide you with colour, beauty, shape, motion and excitement. As you train them to spot minute targets in the sky, you'll also learn to see many other important 'little' things you may be missing, both on the ground and in the air. If you couple your eyes with your brain, you should be around to enjoy these benefits of vision for a long time.

WELL INTENTIONED, BUT...

The pilot of this Cessna 150, who was not quite 20, had recently obtained his unrestricted private pilot licence, and had hired the aircraft for an afternoon's local flying from the farming property on which he lived. It was in fact the first time he had flown since his licence test nearly seven weeks before.

A number of children on school holidays were staying at the farm and the pilot, on his own initiative, made a number of short flights for their benefit, taking two of the children on each trip. The Cessna 150 was not fitted with the optional third seat, and on each of these flights, the second child passenger stood or squatted, unrestrained in any way, in the luggage compartment behind the two seats.

The paddock from which the pilot was operating the aircraft met the requirements of an authorised landing area, but the direction he was using, into the west, entailed on approach to land over a two wire power line close to the down wind fence of the landing area.

Towards the end of his sixth flight late in the afternoon, again with two children as passengers, the pilot was making a long low approach to land. In the glare of the westering sun he failed to notice the proximity of the power line to his approach path, and the aircraft struck the wires with its undercarriage at a speed of about 60 knots. The aircraft swung to the left, sliding sideways along the wires. Stretching them like a bow string, the aircraft quickly decelerated and struck the ground, collapsing the nose leg and compressing the engine mounting structure. The windscreen shattered at the same time and the child in the rear compartment was hurled out on to the ground.

Almost miraculously, though she was knocked unconscious, she was not seriously hurt because the ground where she fell had been recently ploughed and was still soft. The pilot and the other passenger were restrained by their seat belts and also suffered only minor injuries.

AS WE HAVE SAID BEFORE...

AG STRIPS ARE FOR THE EXPERTS!

The fatal accident reviewed elsewhere in this Digest exemplifies the dangers faced by an inexperienced pilot attempting to land on an agricultural airstrip. Accidents of this type are not uncommon, though rarely do they have such tragic consequences. It seems that many pilots are not only unaware of the limitations of strips authorised for agricultural operations only, but are overconfident of their ability to handle their aircraft safely on such strips. Agricultural pilots are of course trained to operate under such conditions, but a relatively inexperienced pilot attempting to use one of these strips can easily inflict serious and expensive damage to his aircraft, if not to himself.

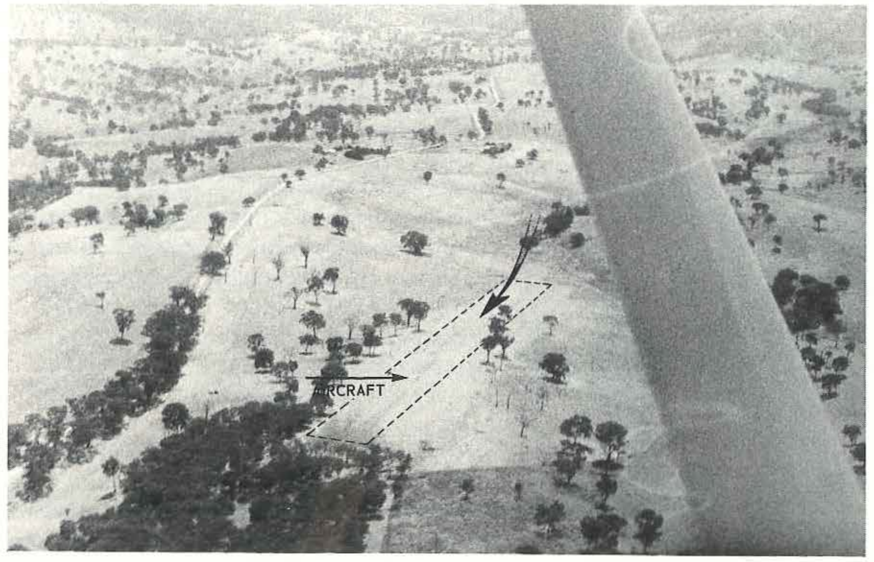
Agricultural strips may fall below the standard of those authorised for normal operations. For example the maximum permissible longitudinal slope for authorised landing areas is 1 in 50. Agricultural strips on the other hand, may slope as steeply as 1 in 8! Again, ALA's are required to have an obstacle free gradient of 1 in 20 at both ends of the strip, whereas an agricultural strip may satisfy this requirement only at one end, rendering it a 'one-way' strip regardless of wind conditions. The operational area of an agricultural strip may also be narrower than that of an authorised landing area.

For these reasons pilots accustomed to landing only at licensed aerodromes or on authorised landing areas, may find that agricultural strips demand a level of skill well beyond their ability. Another recent accident in New South Wales demonstrates this likelihood only too well:

A private pilot had been asked to conduct a cross-country flight by a business colleague who owned a Beech 23 but held only a restricted licence. The flight was to be made to a private airstrip at Tuena, in mountainous country 170 km west of Sydney, to discuss business with a property owner who lived nearby. The pilot's colleague had made all the enquiries about the nature of the strip at Tuena, as well as requesting permission to land.

The information passed to the pilot was that the strip was of a good length, that it was regularly used, that it was a 'bit slopey', that there were no power lines or other obstructions near it, and that the surface was suitable. It had also been arranged that someone would drive up and down the strip when the aircraft arrived overhead, to confirm that the surface was good, and in order to provide an indication of wind strength and direction from the dust raised by the vehicle.

The pilot, who was 50, had only about 150 hours experience and had never landed at other than established aerodromes, but he did not believe he would encounter any difficulty. The flight proceeded as planned from Bankstown, and the aircraft arrived over the strip at Tuena at noon. The actual appearance of the strip caused the pilot some dismay and he made two complete circuits to inspect it, one at some altitude, and the second at 500 feet. As



Aerial view of the strip at Tuena. The direction of approach and position of crashed aircraft are shown.

arranged however, a vehicle drove up and down the strip, and the pilot saw that the dust raised seemed to hover around it with little or no drift. He also saw that there was some slope to the strip, and that it would be preferable to land up the slope. Having been assured that the strip was regularly used, he felt that it must be suitable despite his misgivings, and he prepared to land.

The threshold of the strip appeared to lie between a line of trees well spaced to either side, and the pilot flew a long downwind leg, and lined up on the final approach some distance out from the strip. He had intended to touch down between the trees right at the threshold but during the approach his passengers expressed some concern about the closeness of the trees so he increased power until the aircraft had overflown them, then re-established a normal descent.

However, as the pilot was about to flare for landing, the aircraft seemed to sink rapidly. The pilot applied power, but it landed very heavily. All three undercarriage legs collapsed, and the aircraft skidded forward and slewed to a stop about two thirds of the way along the strip. The pilot and his passengers were not injured, but the aircraft was substantially damaged.

It was later confirmed that the strip was suitable only for one-way agricultural operations. In fact, at the point where the pilot touched down the upward gradient was as much as 1 in 15. This was a far greater slope than any the pilot had handled before.

Landing on an upward sloping surface can be extremely deceptive for an inexperienced pilot. Approaching a sloping strip as he would a level surface, the aircraft's descent path intersects the ground at a far steeper angle than normal. The ground, in effect, rises to meet the descending aircraft, and will usually surprise the pilot by 'arriving' before he is ready for it! Pilots experienced in operating from sloping terrain have for the most part developed the timing and degree of their landing flare to a fine art, but in the accident just described, the slope caught the pilot unawares before he had time to commence flaring. As a result the aircraft effectively flew into the ground at a steep angle of approach.

★ ★ ★ ★ ★

A further example of an accident at an agricultural strip highlights the fact that a pilot, even if able to cope with a landing on excessively sloping terrain, needs to be conscious always of the overall limitations of such strips. In this case, the private pilot concerned had landed a number of times before on a strip at Gough's Bay, at the edge of Lake Eildon in Victoria.

The Musketeer as it came to rest on the strip. The photograph was taken looking back along the approach path.

The strip was about 600 metres long, and aligned roughly north-south. Because the strip had a slight upslope to the south and 60 foot trees at its southern boundary, the pilot considered it suitable only for one-way operations. In fact on all previous occasions, he had landed into the south and taken off into the north.

As he overflew the area in his Cessna 170 on this occasion, the pilot noted from the position of the tethered boats on the lake that there was a strong northerly wind blowing. However, despite this indication of a marked tailwind for a landing into the south, the pilot decided to land in that direction, as he had found before that the strip tended to be sheltered by hills and trees.

The pilot aimed to touch down some 60 metres in from the threshold, and after lowering full flap late on final, he slowed the aircraft to 50 knots. Instead of touching down as expected however, the aircraft floated just above the ground at a high ground speed for about 150 metres. It then touched down, skipped, and touched down again. At this stage the pilot, concerned at the high ground speed and the limited length of strip remaining, decided to go around.

As the aircraft became airborne, he held the nose down to gain airspeed then, approaching 50 knots, retracted one notch of flap. He then raised the nose of the aircraft and began to climb, concentrating on keeping the speed between 40 and 50 knots. But there was insufficient room for the aircraft to outclimb the trees lining the southern boundary of the strip, and it struck their uppermost branches about ten feet from their tops. Although the leading edge of both wings and the front of the fuselage were damaged, the aircraft broke through the trees and remained airborne.

The pilot was able to retain control but the airspeed had dropped sharply, so he lowered the nose again. Conscious then of a 40 foot high powerline immediately below him and that the Eildon township was just ahead, he turned to the left where the ground fell away. But this was to no avail and a little further on, the aircraft was again unable to clear a line of trees. Once again it broke through foliage, but as it had sustained further damage, the pilot decided he would have to put the aircraft down. He closed the throttle, turned off the fuel and ignition, lowered the nose to maintain flying speed and the aircraft struck the ground in an upright attitude on the upslope of a cleared paddock. The impact broke off the port undercarriage leg as well as bending the starboard leg and the aircraft yawed to the left, and slid for nearly 40 metres before coming to rest against a fence. There was no fire, and the pilot and his passengers quickly vacated the aircraft.

As the pilot had correctly assessed, the strip at Gough's Bay is only suitable for one-way operations, because of tall trees at its southern end. Later calculations showed that, even with a large tailwind component, the aircraft should have been capable of completing the landing safely from the point at which the pilot touched down. On the other hand, even under the best possible conditions, including a headwind component, it was not possible to go around safely from this point. Although the pilot had clearly understood the strip was only suitable for one-way operations, he had not recognised this also meant that he was committed to a landing once on the strip.

In summary then, agricultural strips are so designated because they fall below the standards stipulated as the minimum for normal operations. This means that non-agricultural pilots using such strips are not only breaching regulations, but are placing themselves in situations in which their experience and ability may well be insufficient for the safety of their operation. As the accident on page 2 of this Digest shows, compromising safety in this way can have disastrous results.

The damaged Cessna 170 as it struck the fence after the pilot was finally forced to put it down.

View of remaining strip taken from the point at which the pilot attempted to go around. The aircraft's point of impact with the trees is indicated.

HOW FAMILIAR DO YOU HAVE TO BE?

It is obviously impossible for a pilot to know just when he will be called upon to utilise any of the various emergency systems in an aircraft since, by its very nature, an emergency is unexpected. By the same token however, all pilots have a responsibility to be thoroughly familiar with the characteristics of those systems so that, when an emergency does arise, they will be in the best possible position to cope with it.

Emergencies in light aircraft cannot always be effectively simulated and though appropriate procedures can be practised to some extent in the course of normal training, many such exercises of necessity, cannot be carried through to an entirely realistic conclusion. When it is appreciated that in a real emergency, the pilot may have to cope with the situation under conditions of high stress and heavy workload, the importance of a thorough knowledge of the emergency systems becomes clear. This is well illustrated in a recent accident in Queensland involving a Twin Comanche:

An experienced commercial pilot was conducting a charter flight from Cairns to Mareeba and Inkerman. The first two legs of the flight were entirely without incident and, after leaving the last of his passengers at Inkerman, he took off late in the afternoon to return to Cairns.

Just on dusk, about 20 minutes after leaving Inkerman, the generator failure warning light for the starboard engine suddenly illuminated. The pilot checked the ammeter but it showed no discharge. He considered returning to Inkerman but as it was now almost dark and there could have been cattle on the strip, he decided instead to continue to Cairns. As time passed however and it grew darker in the cabin, the pilot was concerned to see that the port generator warning light was also illuminated, though only faintly. Quickly he closed down most of the aircraft's radios, as well as other non-essential electrical equipment.

Instructions placarded on back of undercarriage motor access cover.

Arriving over Cairns about an hour and a half later, the pilot turned on the landing lights and then selected the undercarriage down. As soon as he did this, all the cabin lighting went out and the pilot found himself flying in virtual pitch darkness. The only signs of illumination were the two glowing generator warning lights. There were no indications that the undercarriage had extended so he switched off the landing lights and recycled the undercarriage selector. Again there was no apparent result, but he noticed that the interior lights came on when the selector switch was moved through NEUTRAL. They went out again when the switch was in either the UP or DOWN position.

The pilot advised Cairns Tower that he was unable to lower the undercarriage and would try to extend it manually. At this stage however, because of the aircraft's electrical difficulties, he lost radio contact with the tower.

The pilot then tried to lower the undercarriage manually using the emergency extension procedure. He removed the undercarriage motor access cover from the floor between the two front seats and studied the instructions placarded on the reverse side. He then lifted the small motor release arm into a vertical position, reduced speed to 90 knots and selected the undercarriage switch DOWN. This again deprived him of cabin illumination. Inserting the emergency extension handle into the right-hand socket on the undercarriage retraction torque tube, he tried to push it forward — but it would not shift. He then tried the left-hand socket but, even using both hands, his efforts were again to no avail.

During this time, the tower had been calling the aircraft to check on the pilot's progress, but there was no reply. The tower therefore declared the Alert Phase of Search and Rescue procedures and five minutes later when there had still been no contact with the aircraft, either visually or by radio, upgraded this to a Distress Phase.

Meanwhile in the aircraft, the pilot was still trying unsuccessfully to lower the undercarriage. He had tried using a torch to study the placarded instructions but found it too cumbersome in the confined space with all he had to do. He therefore returned the undercarriage selector to the neutral position to regain cabin lighting and after re-reading the placard, made several more attempts to move the emergency extension handle, all the while doing his best to maintain control of the aircraft. At one stage he looked up to find the aircraft nose-up in a 45 degree bank at low airspeed.

Eventually realising that he could not continue this way with any degree of safety, the pilot decided he would have to land the aircraft wheels-up. After flying low past the tower to indicate he was still in the circuit area, he again returned the undercarriage selector to NEUTRAL so that he had sufficient illumination to read the instruments, then carried out a flapless approach to land. The aircraft touched down smoothly and slid for nearly 140 metres before coming to rest. The undercarriage was not quite fully retracted and the main wheel brake units lightly contacted the runway as the aircraft touched down. Damage was confined to the propellers and the underside of the fuselage. Some 25 minutes had elapsed since the aircraft first arrived over Cairns.

* * * * *

When the aircraft was inspected later, it was found that both voltage regulators had developed separate and unrelated defects. As a result, the aircraft's battery had become discharged and when the aircraft arrived over its destination, there was insufficient electrical power to lower the undercarriage in the normal way.

Examination of the emergency extension system disclosed that the system should have functioned normally, except that the motor release arm (see photographs) was very stiff to operate. Nevertheless, it was possible to force it forward through to its full travel and so disengage the motor.

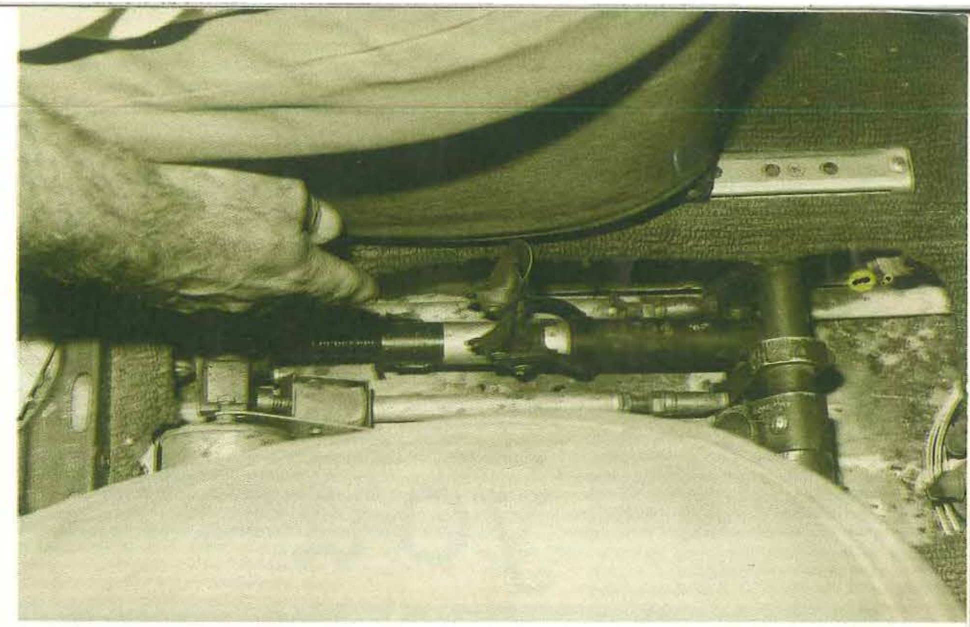
The pilot had over 3000 hours aeronautical experience, of which more than a third had been flown in this type of aircraft. He had even manually lowered the undercarriage once before in a Twin Comanche and had experienced no difficulty in operating the emergency extension system on that occasion.

In the course of the investigation, the pilot twice demonstrated the procedure he had used in his attempts to lower the undercarriage manually. But each time he moved the motor release arm forward only to the vertical position, the point at which excessive force became necessary to obtain any further forward movement. With the lever in this position of course, the undercarriage mechanism was not disconnected from the actuating motor and the emergency operating handle could not be moved. In the conditions of darkness and high work load that existed at the time of the accident, it is clear that the pilot moved the motor release arm only to a point where he felt firm resistance against further movement and was misled into believing it had reached the limit of its forward travel.

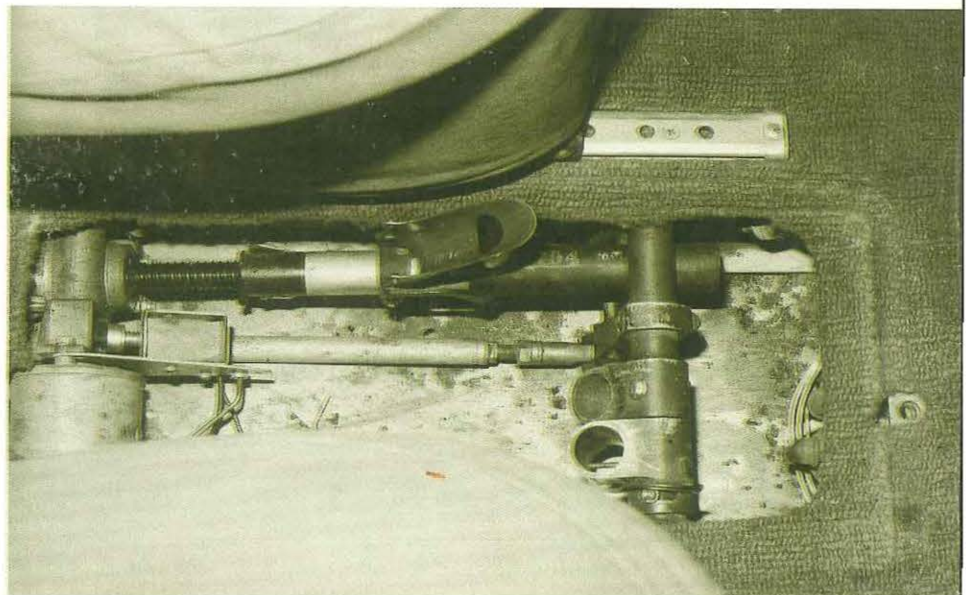
On most aircraft types, the emergency systems and operating procedures are thoroughly demonstrated during endorsement training. After this initial training however, there may be few opportunities for revision and pilots can become 'rusty' in their knowledge of emergency procedures in quite a short time. These difficulties are compounded in the Twin Comanche by the fact that, once the undercarriage has been lowered using the emergency extension system, it cannot be retracted again in flight. Instead the aircraft must be jacked up on the ground, and the undercarriage mechanism re-set under the supervision of a licensed engineer. As this can take up to several hours, the costs and delays involved clearly make it impractical to demonstrate the operation of the system during routine training. Thus, in the absence of a practical demonstration, a thorough understanding of the undercarriage emergency extension system can only be acquired by careful study of the procedures described in the aircraft owner's manual, and cockpit placards and instructions relating to its operation.

Certainly it is only too easy to be wise after the event and there is no doubt that, in this case, the pilot was working under extremely difficult conditions. His decision to abandon his attempts to lower the undercarriage manually was correct in the circumstances and the subsequent wheels-up landing resulted in minimal damage. Yet the pilot **had** operated the emergency extension system in a Twin Comanche before and had very extensive aeronautical experience, both generally and 'on type'.

Obviously, even this was not enough, and the accident serves to emphasize the need for constant review of emergency procedures if a pilot is to cope safely with any contingency likely to be encountered in an actual emergency situation.



Top: Position in which pilot placed motor release arm, believing he had disengaged the motor.



Bottom: Undercarriage motor release arm in full forward travel position necessary to disengage motor.

if you operate in the bush — mind how you do it

No one would argue that operating an aeroplane from a doubtful or unknown surface can be a risky business, and that it is only wise and sensible to satisfy oneself that the surface is safe before committing an expensive piece of aeronautical machinery to its tender mercies.

Just how risky it *can* be, is evident from the three instances depicted on these pages. The three pilots concerned, not without some justification, *thought* they had taken reasonable precautions. Yet their gambles, though seemingly a certainty, didn't quite come off, showing convincingly that each phase of ground operation can be vulnerable on any landing area that leaves the slightest room for doubt.

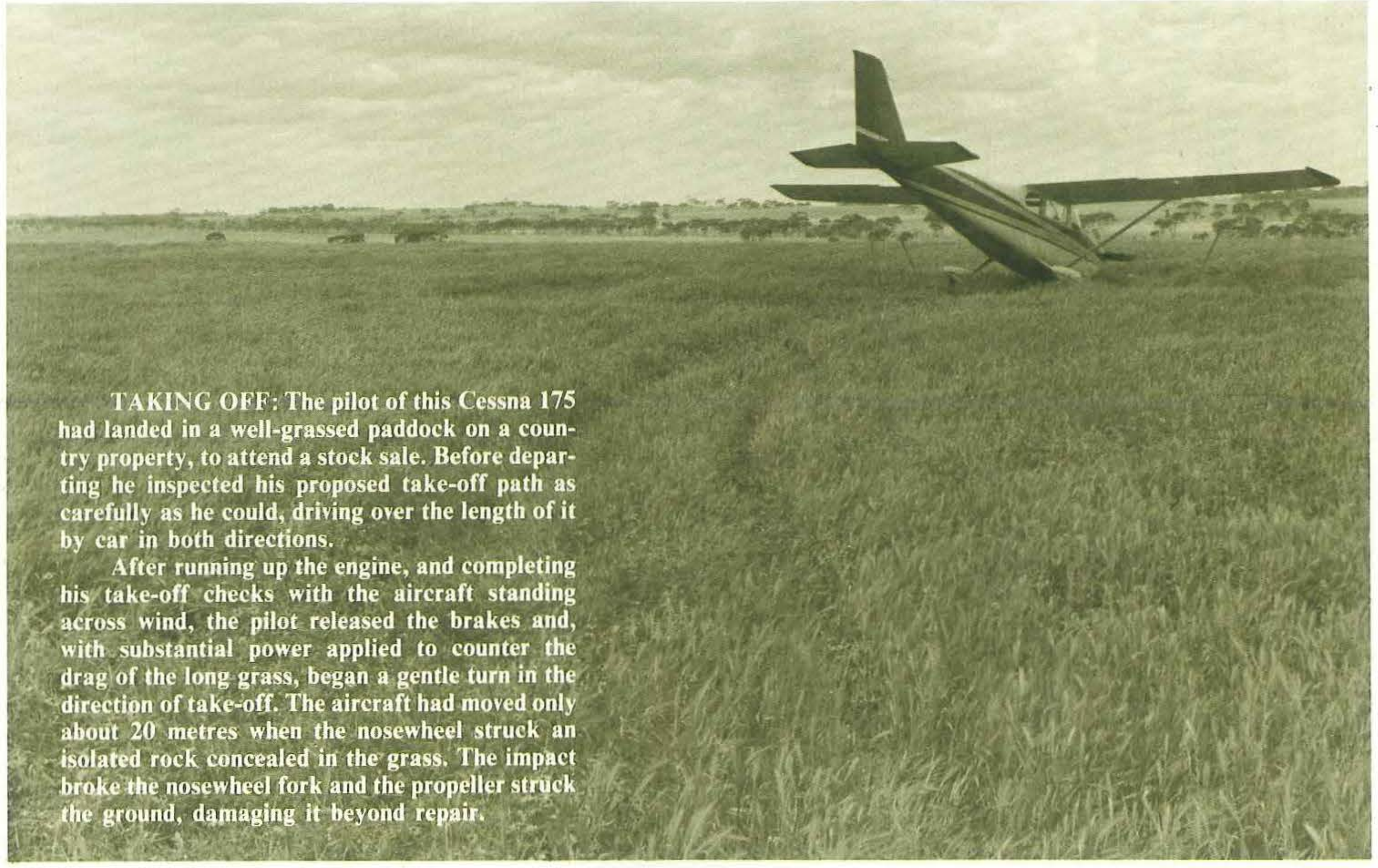
TAXI-ING: Heavy rain had washed out a small erosion gully about two metres into the side of this mining site strip. The washaway happened to be almost opposite the entrance to the strip's taxiway. The pilot of the Cherokee Six in the picture knew the hazard was there, having used the strip many times before.

But after landing on this occasion, the pilot allowed himself to be distracted by the conversation of his front seat passenger. While taxi-ing to the parking area, and positioning the aircraft to turn into the taxiway, the Cherokee suddenly gave a violent lurch, swung to the left and came to an abrupt stop with the port wing and tail scraping the ground.

Climbing out, the pilot found that the port undercarriage had dropped into the washaway, and been torn from its attachments.

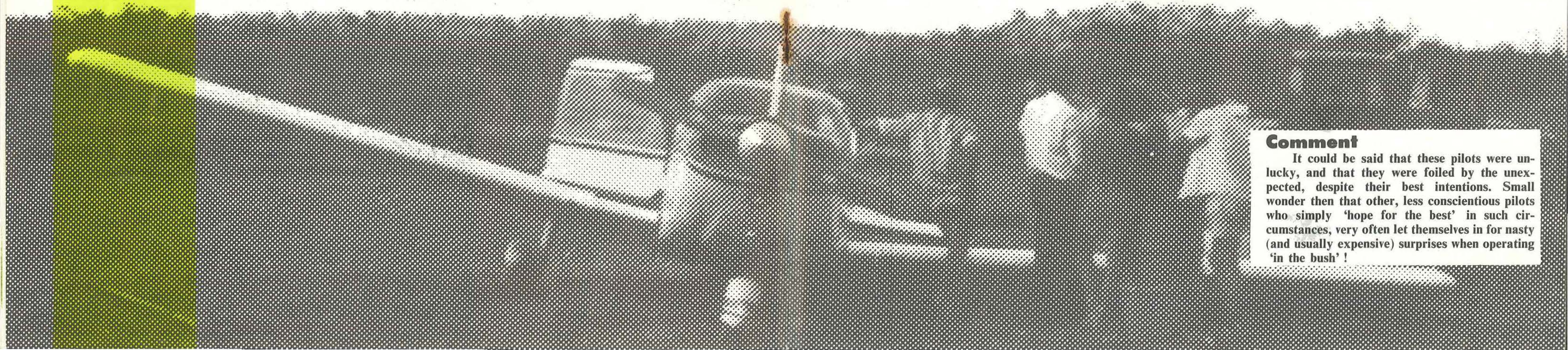
LANDING: This Cherokee Arrow hit a rock while landing on a station property airstrip that had just been built. The starboard undercarriage leg was bent back and its mounting structure pushed up through the wing. The football-sized rock had obviously been dislodged from beneath the surface by a bulldozer, during the strip's construction.

Though the pilot had made a most careful inspection run over the strip before landing, 'he had not examined it from the ground or checked its serviceability with the station manager'. The rock, which was the same colour as the surrounding soil, was very difficult to see from any distance away.



TAKING OFF: The pilot of this Cessna 175 had landed in a well-grassed paddock on a country property, to attend a stock sale. Before departing he inspected his proposed take-off path as carefully as he could, driving over the length of it by car in both directions.

After running up the engine, and completing his take-off checks with the aircraft standing across wind, the pilot released the brakes and, with substantial power applied to counter the drag of the long grass, began a gentle turn in the direction of take-off. The aircraft had moved only about 20 metres when the nosewheel struck an isolated rock concealed in the grass. The impact broke the nosewheel fork and the propeller struck the ground, damaging it beyond repair.



Comment

It could be said that these pilots were unlucky, and that they were foiled by the unexpected, despite their best intentions. Small wonder then that other, less conscientious pilots who simply 'hope for the best' in such circumstances, very often let themselves in for nasty (and usually expensive) surprises when operating 'in the bush'!

JET BLAST

More Dangerous Than Ever!

The fury that can rage unseen behind the jet pipes of large transport aeroplanes on the ground is a hazard that, though still comparatively new to aviation, is becoming increasingly manifest as jet aircraft grow in numbers and individual size. The extent to which this danger is increasing is all too evident from the frequency and variety of jet blast accidents that are occurring both in Australia and overseas. Manoeuvres in terminal areas are of course the most critical situations for accidents of this type.

Some years ago the Digest published a diagram and graph showing the efflux velocities to be expected behind a typical large jet aircraft of the day, at power settings ranging from idling to take-off thrust. These diagrams showed beyond any doubt that the area behind even these first generation jet aircraft was no place to be walking, driving a motor vehicle or taxi-ing a light aeroplane, particularly if the engines were operating at any higher thrust than idling.

Yet despite this and other publicity early in Australia's 'jet age', despite the accidents that have occurred since, and despite the dangers that should be evident in themselves to persons working in an aviation environment, jet blast accidents have çontinued to occur. Now, with the advent of immense wide-bodied jet aircraft like the Boeing 747, the Lockheed Tristar and the McDonnell-Douglas DC10, the problem can only intensify as never before.

Not only do the much higher-thrust engines fitted to these aircraft produce much larger efflux velocity patterns, moving some 300 percent more air per second than their predecessors, but also the jet blast itself is much harder to detect. Earlier jet engines exhausted a combination of smoke and shimmering heat which provided a visual warning when running on the apron or in close proximity to other aircraft, but the cooler and cleaner jet exhausts of the new by-pass engines are virtually invisible throughout much of their high velocity range.

Another subtle, but highly dangerous characteristic of these new engines on the ground is their greatly increased inlet duct suction area. Inlet suction is of course a hazard with any jet engine operating on the ground because there is never any visual boundary to the affected area. But it is especially dangerous with these new large engines because of the very extent of the inlet suction area and the fact that the engines themselves have no inlet guide vanes to act as a final filter for large objects. At idle power the inlet danger zone for these engines can be defined as a semi-circle of 5.5 metres radius in front of the engines, but at take-off power, the radius of the danger area increases to no less than nine metres.

As well as this, some of the newer tri-jet aircraft such as the DC10 and the Lockheed 1011 have engines which are more powerful even than those originally fitted to the Boeing 747. The destructive force of these new engines can be appreciated from the fact that, even 35 metres behind the aircraft, the blast generated as it begins to taxi is about 80 knots, a force comparable with that of a hurricane.

The following tables convey some idea of the energy released in the jet blast of these modern large aircraft, and provide a guide to the blast velocities likely to be encountered under various operating conditions:

FOUR ENGINE WIDE-BODY JET

Power	Distance behind tail	Exhaust velocities
IDLE	10m	40kt
	60m	30kt
BREAKAWAY	30m	70kt
	60m	60kt
	145m	30kt
TAKEOFF	30m	130kt
	80m	90kt
	130m	70kt
	220m	55kt
	480m	45kt

THREE ENGINE WIDE-BODY JET

Power	Distance behind tail	Exhaust velocities
IDLE	15m	65kt
	30m	40kt
BREAKAWAY	15m	175kt
	60m	65kt
	100m	45kt
TAKEOFF	50m	165kt
	70m	130kt
	100m	95kt
	150m	65kt
	200m	50kt
	260m	40kt
	340m	30kt

One particular problem which seems to be common to many jet blast accidents and incidents is the unpredictability of the effect of wind on jet effluxes. The velocities to be expected at various distances behind the jet pipes of engines operating at different thrusts have been measured and widely publicised over the years and are probably understood, to some degree, by most pilots and ground engineers who customarily work with jet aircraft. Yet practical experience has shown that the actual velocities encountered can differ widely from the published data under varying wind conditions. The effect of wind on jet effluxes has still not been fully explored, but accident experience indicates that a downwind or upwind component does not simply add to or subtract from the velocity of the efflux at a particular point, but rather carries the whole efflux velocity pattern bodily in the direction in which the wind component is acting. This has much the same effect as though the source of the efflux were moved closer to, or further away from the point affected by the blast. Because the blast velocity increases exponentially as the distance from the jetpipe decreases, wind components can produce very substantial variations in the expected efflux velocity, particularly in the case of a strong wind component acting in the same direction as an aircraft's engines. This factor has been responsible for substantial damage to other aircraft on several occasions in Australia.

In one such instance, a DC3 lost one of its elevators and had its other tail surfaces severely damaged when it taxied behind a Boeing 727 with its engines only idling. At no time was the tail of the DC3 closer to the Boeing's jet pipes than 30 metres, and in normal circumstances an efflux velocity of less than 30 knots is all that might have been expected. This figure is certainly much less than the velocity that would have been required to inflict the damage sustained by the DC3, and the answer appears to lie, at least in part, in the wind which was blowing at the time. The Boeing was facing almost directly into a gusty westerly wind of 16 knots, and it is apparent that this had a marked effect in carrying the blast from the jet downwind towards the DC3, producing the same effect as if the jet's engines had been moved closer to the DC3. As a result, the DC3 was buffetted by much higher efflux velocities than expected.

It also has been found that crosswinds can move the unseen blast from where it is to be expected directly behind a jet aircraft, to one side or the other. For example, a crosswind of 30 knots can displace the 40 knot efflux zone anything up to 75 metres to one side of an aircraft whose engines are operating only at taxi-ing power. A sudden unexpected gust of this magnitude could obviously upset a taxi-ing light aircraft or cause damage to equipment and vehicles on the apron of an airport.

A further complication is introduced by the fact that some large aircraft have four wing-mounted engines, others have two or three tail-mounted engines, while some types have both wing-mounted and tail-mounted engines. On a large aircraft, the engine position can have a very substantial effect on the blast velocity a given distance behind the tail of that aircraft. Pilots of other aircraft, as well as personnel moving luggage carts, passenger steps, or other equipment on airport aprons, need to be mindful of this factor in assessing the magnitude of jet blast hazards in their day to day operations.

Also, because of the very high location of the tail-mounted engines on the larger tri-jet aircraft such as the DC10 and the Lockheed 1011, previously unforeseen jet blast hazards are now being presented, particularly to terminal building windows, and even to spectators watching from observation decks. These engines should not be operated above idle power on the apron or in terminal areas.

Obviously, the most critical phase of jet aircraft operations on congested aprons is when power is increased to breakaway thrust to get an aircraft moving. This is especially so if, at the same time, the aircraft has to turn sharply, or if the path across the apron is slightly uphill. In these circumstances, quite large amounts of thrust are required for a short period. Efflux velocities of more than 70 knots have in fact been measured 50 metres behind the jet pipes of conventional domestic jet aircraft using their minimum breakaway thrust. The intensity of such a blast and the area it affects is sometimes very difficult for pilots to appreciate from the cockpit and it is sometimes all too easy for a crew to taxi away entirely oblivious of the havoc that their departure may have wrought in terms of overturned light aeroplanes or damage to other property and equipment. A quite recent accident has shown that, even when the crew of a jet aircraft are aware that a light aircraft is in the vicinity to the rear of their aircraft, and they consequently exercise care in the use of power when beginning to taxi, the light aircraft can still be tipped on its nose or wing tip.

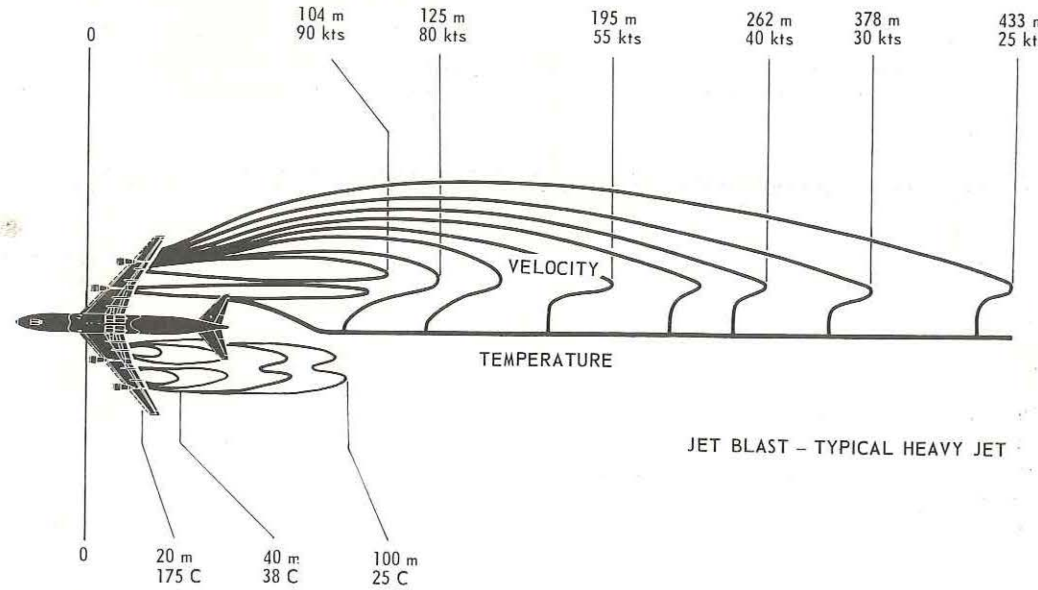
Pilots of jet aircraft need to be acutely aware of the potentially destructive capabilities of the machinery under their control and exercise fine judgement in the selection of power settings during ground manoeuvring. Operations Manuals normally specify maximum taxi power settings, or indicate if 'critical' engines should not be operated above idle settings in terminal areas. As a general rule, the chances of jet blast damage in these situations can be minimised by:

- Applying equal thrust on all engines (except where otherwise indicated) to start the aircraft rolling.
- Allowing time for the engine to spin-up, and for the aircraft to begin to move with the power selected, before resorting to more thrust.
- Remembering that in the breakaway thrust range, even a slight further increase in thrust lever setting can close surge bleed valves and result in more power than required.
- Waiting until the aircraft begins to roll before initiating any turn.
- As soon as possible reducing thrust to the minimum necessary after the aircraft is moving.

As already mentioned, the majority of jet blast accidents have occurred whilst taxi-ing in terminal areas, following the initial application of 'breakaway' power, but a likely accident situation can also develop elsewhere if an aircraft has to stop unexpectedly and breakaway power is subsequently re-applied with the aircraft pointing in an unfavourable direction.

To guard against this situation, pilots, aircraft marshallers and, where involved, Air Traffic Controllers, should plan the proposed ground movements of jet aircraft to ensure that they will not be required to stop where their jet exhausts can cause damage to other aircraft, ground equipment or personnel. Where any doubt exists pilots should request the assistance of ground equipment to re-position their aircraft.

But it is not only aircrew and ground staff responsible for the operation of jet aircraft that need to be concerned with the problem of jet blast. Although it is obvious that a number of variables can be involved in predicting the effect of jet blast, pilots of other types of aircraft should nevertheless know something of what is to be expected in the wake of a large jet at the thrust settings likely to be encountered on an airport apron. Light aircraft are, of course, the most vulnerable of all, and should never be positioned or manoeuvred behind jet aircraft. Many accidents have occurred where light aircraft have been turned over by jet blast in such circumstances. In one case, a light aeroplane, holding closer to the duty runway than the normal holding point, was actually overturned by blast from a Boeing 747 which was taking off.



JET BLAST – TYPICAL HEAVY JET

Light aircraft operators should also exercise caution when parking their aircraft in areas where jet operations are conducted. Accidents to light aircraft have sometimes resulted from unseen structural damage inflicated by jet blast. In one instance overseas, damage to the flying controls of a light twin-engined aircraft was not detected during the pre-flight inspection and it later crashed on take-off.

Whenever possible, the same principle should apply to other aircraft but when this is not practicable (and it has to be admitted that much wider separation of airline aircraft on aprons would be impracticable) the maximum available separation from operating jet engines should be utilised. In normal circumstances, the existing spacing provided by taxi guidelines is sufficient for safe operation, but, in some situations, damage from jet blast can obviously occur if proper precautions are not taken. It is therefore important that aircraft always follow nose wheel guidelines as closely as is possible to ensure that designed blast clearances are maintained, and that pilots, required to taxi in the vicinity of jet aircraft, maintain a high degree of vigilance so as to be alert for the signs of danger.

There are, of course, difficulties in the way of doing this. For example, it may not be immediately evident whether or not a parked jet has its engines running. But there are usually some indications which a knowledgeable pilot can interpret. As a result of the jet blast accident to the DC3 already referred to, the Department introduced a requirement for civil jet aircraft to have their anti-collision beacons switched on whenever their engines were running. However, as this requirement does not necessarily apply to military aircraft, a military jet with engines running may not display an anti-collision beacon, and should therefore be regarded with great caution at all times. Pilots must also bear in mind that anti-collision beacons on a jet aircraft, even when displayed, do not provide an infallible signal, as they give no indication of the additional danger that exists when a jet aircraft is running its engines at abnormally high power.

Pilots taxi-ing in the vicinity of a jet aircraft should therefore do so with the possibility in mind that its engines not only might be running, but might be operating at high power, particularly if a bleed air starting procedure is being used. This necessitates running at least one engine at high power while the other engines are started in turn. So whether or not the jet aircraft is displaying a rotating beacon, astute pilots will be wary of its jet pipes and will watch for signs of other significant activity, such as the position of ground engineers, heat haze emanating from the jet nozzles, dust movement on the apron, and so on. If it is really necessary to taxi close behind a parked jet displaying no anti-collision beacons, it is wise, before taking another aircraft into the danger area, to establish positively that it is safe to do so. Most jet operations take place at

aerodromes with radio communication facilities, and pilots should use them to ensure that where they intend to taxi is safe. At aerodromes where no ground communication facilities exist and manoeuvring space is limited, pilots should communicate with the jet aircraft itself to establish its operating condition.

As already pointed out, despite numerous warnings on the dangers of jet blast, accidents of this sort are still being reported with discouraging repetition. Numerous accidents have occurred in which passengers or airline personnel have been injured when they were either struck by debris blown by jet blast, or were themselves lifted off the ground. Property damage, both to terminals and ground handling equipment, has also been widespread. Pilots-in-command of jet aircraft, as well as ground engineers supervising the starting and dispatching of jet aircraft, consequently carry an important responsibility for the safety of other aircraft, vehicles and personnel on the apron, and should always ensure that no danger is posed to other aircraft, personnel or equipment before the engines are started.

Two sound rules to follow are:

- Plan the aircraft's departure from the terminal area so as to minimize any risk of jet blast damage.
- If in doubt call for ground equipment to move the aircraft.

There is a long established and well-founded tradition that loaded guns should never be handled in a way that their accidental discharge could do harm or inflict injury. In view of the fact that the equally real danger of jet blast has become so manifest in the comparatively few years that large jet aeroplanes have been in general use, it is surely no more than good sense to regard the jet pipes of these aircraft with a similar philosophy of respect.

727 FAILS TO OUTCLIMB WINDSHEAR

After taking off from the Stapleton International Airport, Denver, Colorado, a Boeing 727-224 climbed to about 100 feet then lost height and crashed near the departure end of the runway. All 134 occupants survived the crash, but 15 were seriously injured.

At the time of the accident, a thunderstorm with associated rainshowers was moving over the airport. The thunderstorm was surrounded by numerous other thunderstorms and associated rainshowers but none of these was in the immediate vicinity.

The Flight

The aircraft was operating a scheduled passenger flight from Portland, Oregon, to Houston, Texas, with intermediate stops at Denver, Colorado; Wichita, Kansas; and Tulsa, Oklahoma. With a crew of seven and 127 passengers, it had departed the passenger terminal at Stapleton International Airport shortly after 1600 hours local time.

Before beginning to taxi, the crew had received the automatic terminal information service which gave the 1537 Stapleton weather as: 'Temperature 84°F, wind 070 degrees at 15 knots altimeter setting 30.03 in.' But when Denver tower cleared the aircraft to taxi to runway 35L, it reported the wind as 300 degrees at 14 knots.

Two other flights preceded the aircraft on take-off from runway 35L. At 1605, the tower had cleared a Boeing 727-100 for take-off, reporting the wind as 250 degrees at 15 knots with gusts to 22. After becoming airborne, that aircraft reported 'some pretty good up and downdraughts out here from two to three hundred feet'. The 727-224 did not receive this report as it was still on the surface movement frequency.

Two minutes after this, the tower cleared a Convair 580 for take-off, informing it that the wind was 280 degrees at 13 knots with gusts to 22, and that the 727-100 had reported updraughts and downdraughts at 200 to 300 feet. The Convair acknowledged the information, but again the 727-224 did not receive it because it was on the other frequency.

Finally, just before 1609 hours, the 727-224 itself reported ready for take-off, and was cleared to hold in the take-off position.

At 1609 the now airborne Convair called that 'there's a pretty good shear line about halfway down 35'. Asked by the tower for the altitude of the shear line the Convair replied, 'Oh about just like that other airplane called it, about 200 feet'. The Boeing 727-224 waiting to take off then advised that it had copied this call.

The tower cleared the Boeing 727-224 for take-off at 1610 informing it that the surface wind was 230 degrees at 12 knots and that there had been 'reports of pretty stout up and downdraughts . . . out there at 200 to 300 feet'. The aircraft acknowledged both the clearance and this information.

The first officer was flying the aircraft and, using maximum take-off thrust with all instrument readings normal, he rotated the aircraft at V_1 (which was also V_R) to a pitch attitude of between 13 and 15 degrees.

The aircraft entered heavy rain as it lifted off the runway about 1450 metres from the threshold, and the captain turned on the windshield wipers. In response then to the first officer's command, he retracted the undercarriage and the aircraft climbed normally to 150 feet to 200 feet, accelerating to an indicated airspeed of about V_2 + 5 knots. At this point the airspeed fluctuated, then decreased to V_2 - 5 knots, and the first officer relaxed back-pressure on the control column. Feeling the aircraft sink and seeing the airspeed now at V_2 - 20 knots, the captain took control, advanced the power levers to maximum thrust, and lowered the nose to a pitch attitude of about 10 degrees. The aircraft continued to descend, and the captain attempted to raise the nose. The stall warning system then activated and the aircraft struck the ground on the right shoulder of runway 35L, just south of the end of the runway. After sliding some 600 metres, it came to rest on a road.

Investigation

Though the Boeing's fuselage was split open circumferentially in two places the wreckage remained generally intact. The trailing-edge flaps were extended 15 degrees, the leading-edge flaps and slats were fully extended; and all spoilers and undercarriage legs were retracted. The three engines remained in their mountings and their thrust reversers were in the forward position. Although the fuel lines to the engines were stretched because of fuselage damage, they remained intact and contained fuel. There was no evidence of any failure or malfunction in the aircraft's systems, structure, or powerplants before the aircraft struck the ground.

The aircraft's take-off gross weight was 69 847 kg, slightly below the maximum allowable weight for take-off on runway 35L and the centre of gravity was within prescribed limits.

Stapleton International Airport, 5330 feet AMSL, is about eight kilometres northeast of Denver. One set of parallel runways, 08R/L - 26L/R, and one single runway, 17R-35L, were available. A fourth runway, 17L-35R, was under construction at the time of the accident. Runway 35L used by the aircraft is 3500 metres long and 45 metres wide.

The terminal forecast for Denver, issued at 0940 and valid for 24 hours on the day of the accident was: 10 000 feet scattered cloud, 14 000 feet scattered, slight chance of an 8000-foot broken ceiling, thunderstorms and light rain showers in vicinity. At the time of the accident, there was no SIGMET in effect for the Denver area. Rainfall records showed that half a millimetre of rain fell at Stapleton Airport between 1520 and 1540.

The captain of the other 727 said that when he landed at Stapleton about 50 minutes before the accident, he had encountered moderate to severe turbulence on the approach to runway 26L. Later while taxi-ing to runway 35L for take-off, he noticed a large dust cloud along the northern portion of runway 35L. By the time he started the take-off, the dust cloud had moved west of the runway.

Although the take-off gross weight of his aircraft was about 4500 kg less than the maximum authorised, the captain of this 727 used maximum take-off thrust and decided to climb at V_2 + 20 knots (10 knots higher than normal) because of the variable surface winds and his experience with the turbulence on arrival. He noticed moderate to severe turbulence almost immediately after take-off and when the aircraft was between 100 and 300 feet above the runway, the indicated airspeed fluctuated considerably and then rapidly decreased by about 10 to 15 knots. He levelled the aircraft momentarily by decreasing the pitch attitude from about twelve to five degrees, regained airspeed, and continued the climb.

The captain of the Convair said that when he aligned his aircraft for take-off on runway 35L, he saw a dust cloud moving eastwards across the runway and the northern half of the runway appeared to be wet. He described his take-off as normal for the near maximum load on board, until they reached an altitude about 300 feet above the runway, where they suddenly encountered moderate turbulence and rain. The indicated airspeed was about 130 knots, but as he began to retract the flaps, the airspeed decreased rapidly to about 120 knots.

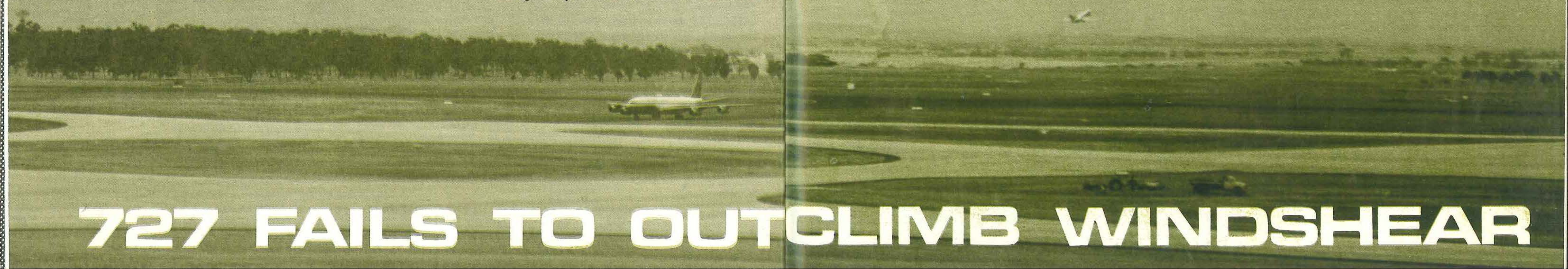
He discontinued the flap retraction, lowered the nose, and the aircraft descended about 100 feet before it regained airspeed. The turbulence and rain then ceased, and he resumed the climb. Two or three minutes later, as he set course towards the southwest, he saw a large dust cloud on the ground. The cloud was moving rapidly north along runway 35R.

An airport construction worker who was in a caravan about 800 metres east of the accident site, said that rain, blown from the south by a very strong wind, began between 1550 and 1555. The caravan began to shake and the lights went out. Some time later, he heard a loud noise and looked out to the north. He saw that the roof had been blown off a construction shed a short distance to the north of his position. He then heard engine sounds and saw the aircraft on the ground to the west.

An aircraft mechanic saw the aircraft as it struck the ground. At the time he was about 600 metres east of the crash site and just west of the construction shed which had lost its roof. He said that the wind had been gusting hard from the south for about 10 minutes before the accident. He estimated that the wind speed varied from near calm to 40 or 50 knots.

Another construction worker, located about 300 metres east of runway 35L, said that when the aircraft passed to the west of his position, all three undercarriage legs were still on the runway. He entered his truck to move it and when he got out a short time later, he looked for the aircraft but could not see it. Instead, he saw a large cloud of dust at the northern end of runway 35L. About five minutes before the accident, a strong southerly wind had blown so hard that he had taken shelter. When the aircraft passed his position, the wind was from the northeast at an estimated eight to 12 knots.

(Condensed from report issued by National Transportation Safety Board, USA)



A third construction worker was driving north along the western side of the runway under construction and was about 600 metres from the north end of runway 35L when the accident occurred. He first saw the aircraft about 200 feet above the runway and watched it descend to the ground. He estimated that the wind was blowing from the southeast at a speed of 25 to 35 knots.

* * * * *

The aircraft was equipped with both a flight data recorder and a cockpit voice recorder. The flight data recorder showed that the airspeed had fluctuated through the take-off and the brief flight. A correlation of both recorders indicated that the tower transmitted wind information to the aircraft before the take-off roll began and that the crew had acknowledged this transmission 65 seconds before impact. The captain's call 'V_1, rotate' was made at an indicated airspeed of about 132 knots, 45 seconds after the crew had acknowledged the wind information. The 'gear up' call was made seven seconds later when the airspeed was approximately 154 knots. About two seconds afterwards, the airspeed decreased from 157 to 116 knots in about five seconds. The aircraft crashed 6.6 seconds later at an airspeed of 126 knots.

Because of the wind problems reported by the other 727 and the Convair, the flight data recorders of these aircraft were also examined.

The flight recorder traces of the 727-100 did not appear unusual until about 43 seconds after the take-off roll began; but during the following 15.6 second interval the indicated airspeed decreased from 157 to 134 knots. As airspeed decreased, the altitude increased for 6.5 seconds, decreased slightly for about two seconds, and then began to increase again. During this interval also, the vertical acceleration oscillated between a maximum of 1.31 g and a minimum of 0.27 g.

Thirty-seven seconds after the Convair's take-off roll began, its airspeed began to vary irregularly. This continued throughout the following one minute eight seconds. About 17 seconds after liftoff, the airspeed decreased from 155 knots to 119 knots in 10.8 seconds. During the latter period, the recorder showed that the altitude had remained almost constant at 250 feet above the runway, and the vertical acceleration oscillations increased from about 1.15 g to 1.4 g.

Analysis

Weather radar returns and witness reports indicate that between 1600 and 1620 hours, a thunderstorm developed a short distance west of Stapleton Airport, moved over the northern portion of the airport, dissipated, and moved east-northeast of the airport. The thunderstorm's development and existence were not readily visible, either to air traffic controllers or to flight crews, because its base was high and it was surrounded by other cumulus clouds and thunderstorms with high bases.

As it began to dissipate, the thunderstorm generated numerous downdraughts. The downdraughts were not accompanied by the usual heavy rainshafts because the low relative humidity caused much of the rain to evaporate before it reached the ground, again making the thunderstorm less apparent. However, because the evaporation further cooled the descending air, causing it to descend even more rapidly, the downdraughts associated with the thunderstorm were probably severe near ground level and produced a situation conducive to wind shear.

From evidence of the meteorological conditions, analysis of surface wind conditions and the 727-224's performance, flight data recorder information from the other 727 and the Convair, as well as the observations of witnesses, the NTSB concluded that all three aircraft departing from Denver encountered wind shear at critically low altitudes. In view of this conclusion, the NTSB sought to determine the reason for the 727-224's failure to negotiate the wind shear, particularly in view of the fact that the other 727 and the Convair were able to do so.

The surface wind analysis indicated that the thunderstorm over the northern portion of the airport probably contained more than one centre of divergence. About the time that the 727-100 was taking off, the northern portion of the runway was probably under the influence of relatively weak centres of divergence on both sides of the runway, with a strong centre of divergence about two kilometres west of the centre of the runway.

This 727 probably passed through the area of convergence after it became airborne, which would account for the moderate to severe turbulence it experienced. However, the tailwind it encountered shortly after lift-off was probably produced by the relatively weak centre of divergence and was comparatively slight. The aircraft lost 23 knots of airspeed in 15.6 seconds, or an average of 1.47 knots per second.

When the Convair began its take-off, the pattern had changed because the storm was moving east and the northern portion of the runway was probably influenced more strongly by the main centre of divergence which was then about 1.5 kilometres west of the runway. Also, the two weaker centres had moved east so that one was almost directly over the runway. This centre probably produced the rain and turbulence which the Convair encountered. The tailwind which this aircraft encountered was probably greater than that experienced by the 727-100 because of the increased influence of the main centre of divergence. The Convair lost 36 knots of airspeed in 10.8 seconds — an average of 3.33 knots per second.

By the time the 727 involved in the accident had begun its take-off however, the main centre of divergence had moved even further eastward and was dominating the surface wind flow on the northern portion of the runway. The line of convergence had moved farther south which would have provided considerable variations in wind during the take-off. Shortly after lift-off, the aircraft would have encountered a situation in which the wind changed rapidly from a headwind to a tailwind of substantial magnitude. The airspeed loss of 41 knots in 5.0 seconds — an average loss of 8.2 knots per second — reflects the severity of this change.

Notwithstanding the existence of the thunderstorm over the northern portion of the airport, the NTSB concluded that the weather information available to the aircraft was adequate except for wind information. Although the winds reported by the tower reflected considerable variation in both direction and speed, this information was available from only one anemometer located about 550 metres southeast of the threshold of runway 35L. Consequently, the surface winds over the northern portion of the airport were unknown. No other wind information was available except that reported by the preceding aircraft.

The NTSB believes that, if the means had existed to measure and report the wind shear that existed along and above runway 35L, and to relate these measurements to aircraft performance, the crew of the Boeing 727-224 would have been better prepared for the conditions they encountered and been able to make an intelligent decision on whether or not to take-off. Under the circumstances, with limited wind information, good visibility, and high cloud bases, the captain's decision to take-off on runway 35L cannot be faulted.

However, based on the aircraft performance analysis the NTSB concluded that the accident was unavoidable after the aircraft encountered the wind shear. At the altitude and airspeed at which the encounter occurred, the aircraft was performing near its maximum capability, and the crew, after applying full thrust, could do nothing more to counter the aircraft's descent.

Whether different take-off procedures would have enabled the crew to negotiate the severe wind shear is not known. Any procedure that will increase the aircraft's total energy rapidly will make the aircraft less vulnerable to wind shear, but such procedures have limitations when other operational factors such as obstacle clearance and engine failure are taken into account. For this reason, any change in take-off procedures needs to be carefully considered to preclude reducing one hazard at the expense of increasing others.

Nevertheless, in view of the wide-spread publicity already given to wind shear, the NTSB believes that the airline could and should have taken more positive action to provide their crews with information and training on this problem. In this instance such training would have at least alerted the crew that a serious hazard had been reported to exist along their intended departure path.

Probable Cause

The National Transportation Safety Board determined that the probable cause of this accident was the aircraft's encounter, immediately following take-off, with severe wind shear at an altitude and airspeed which precluded recovery to level flight; the wind shear caused the aircraft to descend at a rate which could not be overcome even though the aircraft was flown at or near its maximum lift capability throughout the encounter. The wind shear was generated by the outflow from a thunderstorm which was over the aircraft's departure path.

Comment

The subject of wind shear is a complex one on which much research is at present being conducted by various aviation institutions and authorities throughout the world. As many readers will be aware it has also been the subject of a good deal of discussion in technical aviation publications in recent months.

Even before the investigation of the accident reviewed on these pages, the National Transportation Safety Board in the United States had cause to explore the problems associated with wind shear in some depth. The Board had done so as the result of several accidents to large aircraft which had occurred during precision instrument approaches. The latest and perhaps most significant of these NTSB reports, involving a Boeing 727-227 approaching to land at New York, was recently reproduced by the Department and distributed to Australian operators of large aircraft.

Since that time, the Department has released an investigation report on the accident to a Fokker Friendship at Bathurst, N.S.W. This aircraft crashed during an attempt to go around from a missed approach which was made because of misalignment with the centreline of the runway. In the words of the report, the accident resulted from 'a large change in the horizontal wind component, or an associated downdraught' produced by an isolated but very active cumulus cloud cell in the vicinity of the aerodrome.

Together with the 727 take-off accident reviewed here, this Australian accident shows that the effects of wind shear can be substantially similar whether encountered on take-off or during a landing approach. Both situations can be hazardous at low altitudes and at normal take-off and landing speeds.

The badly damaged Boeing 727 brought down by wind shear after taking off from Stapleton Airport.

OVERSEAS ACCIDENTS

..in brief..

FAULTY INSTRUMENTS — STRUCTURAL FAILURE

Late in the afternoon, a Twin Comanche, with the pilot and two passengers on board, taxied out for take-off at Bembridge aerodrome on the Isle of Wight, U.K. The cloud base, which had been lowering throughout the day, was only 300 feet, and the visibility was reduced to less than 1400 metres in rain and drizzle. Very soon after taking off, the aircraft was seen to disappear into cloud.

A few minutes later, the Twin Comanche was heard circling at low level to the west of the aerodrome and was also sighted flying slowly in and out of the cloud base.

Not long afterwards, its engines were heard making a noise like that of an aircraft performing a loop. The Twin Comanche then emerged from the very low cloud base at high speed in a shallow dive. Flying just above the ground, it banked sharply to the right, turned to the left again, then suddenly pulled into an almost vertical climb to avoid hitting a farmhouse in its path. The noise of the engines increased at the same time, as though the pilot had applied full power. A moment later there was a loud crack, and the aircraft fell away into a steep dive, and crashed to the ground with great force. The visibility in the area at the time of the crash was about 800 metres.

It was found that the outer sections of both wings had separated from the aircraft before it struck the ground, and that they had both failed as a result of an excessive positive 'g' loading. It was also established that both the vacuum driven artificial horizon and the electrically powered turn and slip indicator fitted to the aircraft, were unserviceable and inoperative at the time of the accident.

The pilot, aged 59, held a private licence with a rating, issued nearly 20 years before, for multi-engined aircraft of less than 5682 kg (12 500 lbs) maximum take-off weight. However, as he had not flown a multi-engined aircraft for more than 13 months, this rating was invalid. His licence also included an IMC rating, but this had lapsed four years before the accident.

In accordance with the requirements of the aircraft's Certificate of Airworthiness, the aircraft was due for an inspection 23 days before the accident. This inspection which would have included an examination of the vacuum and electrically operated gyro systems, had not been carried out.

Though it was not possible to reach any firm conclusions as to the time or sequence of the instrument failures, it is probable that the artificial horizon was working when the aircraft took off, even if not fully serviceable, but unknown to the pilot, the turn and slip indicator had already failed. Thus when the artificial horizon also failed completely after the aircraft had entered cloud, the pilot quickly became disorientated.

It is unlikely, in the very short time available to him after the aircraft emerged from cloud, that the pilot was able to bring the aircraft fully under control. Had the visibility been better, it is possible that the pilot could have orientated himself more quickly and regained full control. But in the conditions which existed, the pilot was deprived of a natural horizon, and the limited view he had of the ground would have been scarcely sufficient to establish the attitude of the aircraft.

The final paragraph of the official investigation report on this accident succinctly sums up the lesson to be learnt from it: **'It has to be said in the interest of preventing further occurrences of this nature that the accident could most probably have been avoided if in the first instance the instruments in question had been maintained to the approved standard and subsequently the normal pre-flight instrument checks had been rigorously carried out.'**

—Department of Trade, U.K.

UNPLANNED DIVERSION

In Texas, U.S.A., the crew of a Convair 600 were attempting to complete a scheduled return flight from Dallas, Texas, to Memphis, Tennessee, with intermediate stops at Texarkana, El Dorado, and Pine Bluff, Arkansas. At the time of the flight from El Dorado to Texarkana, it was night and a cold front lay between the two cities, with a line of thunderstorms and Instrument Meteorological Conditions.

The crew of the Convair were aware of this weather extending across their proposed route to Texarkana, and before landing at El Dorado, had reported that their aircraft's radar was 'painting a solid line 50 miles west of El Dorado'.

Before departing from El Dorado, the crew conferred with other pilots who had been briefed on the weather situation and, while still on the ground, again used the Convair's weather radar to examine the precipitation echoes to the west. The crew commented on what appeared to be a 15-mile wide break in the line of weather some 35 miles west-north-west of the airport, but the captain gave no indication of the route he intended to take to Texarkana, a direct distance of only 65 nautical miles in a westerly direction.

The crew did not lodge a flight plan, nor did they activate the computer-stored IFR plan that was available to them from the Air Route Traffic Control Centre for the area. Instead, while taxi-ing for take-off, the crew informed the local flight service unit that they were proceeding to Texarkana VFR. There was no further contact with the aircraft after it took off and it subsequently failed to arrive at its destination.

Throughout the following three days, 224 civil and military aircraft flew 1235 hours searching for the missing Convair. One helicopter, with its crew of three, was lost in an accident during this time. The disintegrated wreckage of the missing Convair was finally found on a rocky, tree-covered mountainside, 80 nautical miles north-west of its destination, at an elevation of 2025 feet. All on board had been killed.

Correlated readouts of the aircraft's flight data recorder and cockpit audio recorder, which were recovered from the wreckage in good condition, enabled details of the flight to be reconstructed. This showed that, after taking off from El Dorado, the aircraft diverted to the north of its scheduled route, evidently because the captain was concerned to find a way through the line of thunderstorms. No attempt was made to contact any ground station after taking off.

The first officer was flying the aircraft, with the captain giving heading and altitude instructions. The crew were obviously devoting a good deal of their attention to the weather, observing it both visually and on radar. As the flight continued in a north-westerly direction at altitudes varying between 1500 and 3000 feet, the crew gradually realised that it would not be possible to circumnavigate the northern end of the line of storms. The captain then directed the first officer to fly various westerly headings, apparently in an attempt to find a way through the line of storms.

The crew's conversation indicated that the captain had a general idea of the aircraft's position, but not precise information by which he could determine this in relation to the terrain. There was no evidence that the captain was keeping track of the time flown, or maintaining a dead reckoning position which he could relate to lowest safe altitudes or terrain heights. At times, the aircraft was flying in Instrument Meteorological Conditions.

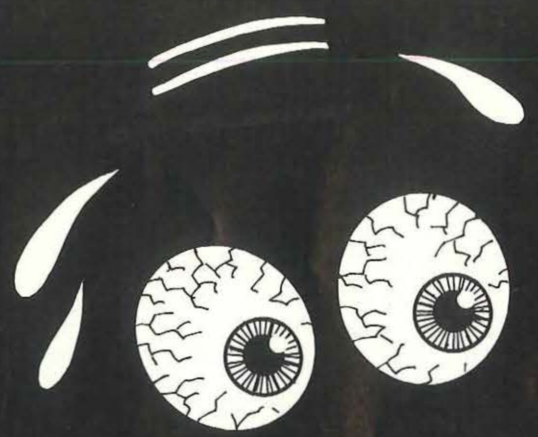
When the aircraft's weather radar began to depict ground returns as well as precipitation echoes, the first officer became concerned about the aircraft's position in relation to the terrain. 'I sure wish I knew where we were,' he remarked to the captain.

A few minutes later he commented, in relation to radar echoes, 'Paintin' ridges and everything else boss, and I'm not familiar with the terrain.' He continued to make comments indicating his concern about the aircraft's position, the lack of information on terrain elevation, and the weather through which they were flying.

Again, two minutes 40 seconds before impact, and after the captain had ordered the first officer to descend to 2000 feet, he said, 'Man, I wish I knew where we were so I'd have some idea of the terrain around this place.' To this remark the captain replied that the highest point in the area was 'twelve hundred' feet, and that they were no where near that point.

About a minute and a half before the impact, the first officer apparently consulted an enroute navigational chart and then announced to the captain that they would shortly be passing over 'the Page VOR'. This VORTAC has both a coded and a voice identification, which is followed by the words, 'Caution, elevation 2700 feet', but the crew had apparently not identified the station aurally. The lowest safe altitude in the area is 4400 feet and the first officer was in the very act of warning the captain, 'minimum enroute altitude here is forty-four hun . . .', when the sound of impact on the cockpit audio recorder cut off his voice in mid-sentence.

—National Transportation Safety Board, U.S.A.



BLACK OUT!

During a period of night circuits and landings at Bankstown recently, a Cessna 172 approved for night VMC operations lost all electrical power while taxi-ing back to the runway holding point for take-off. Later, when the aircraft was inspected to determine the cause of the failure, the battery was found to be fully discharged. There was no fault in the electrical installation and the discharge had been caused solely by an excessive demand on the system.

* * * * *

Operations at night impose heavy demands on an aircraft's electrical system. Navigation lights, communication and radio navigation equipment, instrument lights and rotating beacons may all be on at the same time. If as well the aircraft is carrying out circuit training, the use of the landing lights for frequent take-offs and landings and during taxi-ing can greatly add to this already considerable load.

One of the Department's requirements for approving an aircraft for IFR operations is the preparation of an electrical load analysis. This involves adding together the electrical power requirements of all the equipment in the aircraft during both normal and emergency operations, to determine the total load on the electrical system under all regimes of flight. This figure is then compared with the generating and storage capacity of the aircraft's electrical system to ensure it is adequate to supply the most demanding combination of electrical loads.

In the case of aircraft approved only for VFR or night VMC operations however, no such analysis is required and it is possible for the owner or operator to install as much radio equipment as he desires, provided of course the installation itself is approved. It thus becomes the pilot's responsibility to monitor the electrical load by referring to the ammeter, and to prune the load as necessary to keep it within the capacity of the generating system.

When flying in areas of high density such as the circuit areas of secondary airports or light aircraft lanes of entry, switching on the landing lights makes the aircraft easier to see and helps to reduce the risk of collision. However, aircraft landing lights were originally not intended to be used for long periods and electrical load analyses take into account only the power consumed by an aircraft's electrical equipment for the type of operation for which it was designed. The use of landing lights for an extended time can thus impose an abnormal load on an aircraft's electrical system, even in daylight. Depending on the amount of electrical equipment already operating, an additional heavy demand such as that caused by the landing lights could well overload the system to the point where total electrical failure results.

If an electrical overload is small or only of short duration, it is possible for the demand in excess of the generating capacity to be supplied by the aircraft's battery. In such cases however, the ammeter must be monitored closely and non-essential equipment switched off to reduce the load as soon as it becomes possible to do so.

It must be appreciated that, in common with other systems in an aircraft, the electrical system has definite limitations and overloading will ultimately lead to total failure. The ammeter is not just another dial to fill space on the instrument panel but is as important as the other essential instruments in the aircraft. It must be monitored closely so that any abnormal condition may be recognised and corrected before a total electrical failure occurs. The following diagrams are intended as a guide to the interpretation of the ammeter readings and show indications to be expected during normal operations.

Ammeter readings

- After take-off
  - — High charge to restore battery to normal capacity following engine start and ground checks.

- Normal flight
  - — Smaller positive charge to maintain battery at normal capacity.

- Excessive electrical load
  - — Discharge on ammeter indicates demand exceeds generating capacity — prune load to return indication to that for 'normal flight'.

Leave Nothing To Chance....

The importance of thorough pre-flight checks is a topic familiar to most readers of the Digest, and the pilot contribution which follows, brings to light yet another aspect of this perennial subject. Although the outcome on this particular occasion was a happy one, this in no way diminishes the value of the important lessons to be learned. Nor does it detract from the singularly unfortunate set of circumstances that caused the situation to develop in the first place.

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With several passengers, I had flown from Moorabbin, Victoria to Cambridge, Tasmania, in a Cessna 337. We landed at about 1100 hours and, as is my usual practice, I had the aircraft refuelled straight away. All four tanks were filled to capacity and I checked the contents for water at each drain and sump point — four in all. After the aircraft had been securely tied down, we drove into Hobart for a stay of four days. Twice during this time, I happened to pass the airport and noticed on each occasion that the aircraft was still tied down where I had left it.

When our stay was up and it came time to depart, I prepared an IFR flight plan for our return to Moorabbin, tracking via Flinders Island. When submitting the plan, I was advised that 60 minutes holding was required at Moorabbin because of expected thunderstorm and frontal activity. At our planned departure time of 1700 hours it was raining lightly, with a surface wind of 15 to 20 knots, gusting to 30. After untying the aircraft, I carried out a walk-around inspection, which included checking the engine oil levels and the fuel drains once again.

Just before we embarked however, one of my passengers suggested we should also re-check the fuel levels by removing the filler caps and visually confirming the tanks were full. On the Cessna 337, because of the height of the wing and the fact that the main tank fillers are positioned well outboard of the wing struts, this necessitates using a ladder. Somewhat reluctantly, I finally agreed and the passenger fetched a set of steps from the refuelling point some 50 metres away.

Undoing the caps, I was aghast to discover that the sloping bottom of the port main tank was dry outboard of the filler cap, while the level in the port auxiliary was about two inches below full. Obviously, the fuel had been siphoned from the tanks during our absence. In fact when they were topped-up again a short time later, they took an additional 130 litres. In terms of flying time, this represents 93 minutes at the cruise power settings I normally use.

We finally got away, but not long after we had departed, and while flying over water and in cloud, we were advised that the airports around Melbourne were now closed to all traffic, both VFR and IFR, and that the nearest acceptable alternate was Wagga in New South Wales. As it turned out, there was a short break in the weather as we neared Moorabbin and we were able to land there in VMC.

Had the weather not cleared however, and had we taken off from Cambridge unaware of the deficiency in our fuel load, we could well have found ourselves in the situation of having insufficient fuel to cover the estimated flight time to reach our alternate airport, so being faced with the near certainty of a forced landing in IMC.

Admittedly, the fuel shortage would most likely have been discovered when checking the gauges during the pre take-off checks. But one can never be absolutely certain and if the deficiency had not been noticed, what then? Obviously the only answer in a situation like this is to devote meticulous attention to pre-flight checks and to be doubly sure that nothing is left to chance, even though on occasions the temptation to short-cut can be great indeed.

HAVE YOU A STORY TO TELL?

Most of us who fly have at one time or another found ourselves in a frightening or dangerous situation. Afterwards, in the cold light of reason and reappraisal, it is often clear that there is a valuable cautionary tale in what we have experienced.

If you have a story of this kind which contains a lesson for other pilots, why not let us hear it for possible inclusion in a future issue of the Digest?

An Emergency Well Handled, or An Expensive Mistake?

Arriving in the circuit area of an airstrip on Kangaroo Island, South Australia, the pilot of this Piper Apache lowered the undercarriage for landing. Concerned that he did not obtain a green 'DOWN' indication for the nose leg, he discontinued his approach to land and recycled the undercarriage a number of times without success. He also replaced the bulb in the nose leg indicator lamp, but still no green light came on.

The pilot of another aircraft on the ground at the airstrip then called the Apache on VHF to ascertain the reason for the delay in landing. The Apache pilot explained the situation and, lowering full flap in order to fly as slowly as possible, made several low passes to allow the other pilot to inspect the undercarriage. The pilot on the ground then reported that the nose leg appeared to be extended normally, but that he was unable to see the over-centre lock.

Concerned that the nose leg, though extended, might not be locked down, the Apache pilot decided to take the precaution of feathering both propellers and aligning them horizontally before landing. In this way, they would escape damage should the nose leg collapse after landing.

The Apache pilot informed his colleague on the ground of his intention, then positioned the aircraft on a very close base leg at 1000 feet. Because the landing had to be made directly into the glare of the late afternoon sun, the pilot decided he would cut the final approach leg as short as possible by making a curved gliding approach to the strip from base leg.

After shutting down both engines, feathering the propellers, and positioning them with the starter switches, the pilot realised that the flaps, which he had lowered for the inspection passes, were still fully extended. The pilot accordingly turned in towards the strip earlier than he intended, so as not to undershoot. But by the time the aircraft had descended to a height of only 50 feet, it was still not lined up with the strip, and the pilot saw that he was in fact undershooting. A clump of trees close to the downwind boundary fence prevented him from tightening the turn any further.

Though the aircraft actually touched down on the threshold, it did so at an angle of 30 degrees to the strip's direction and almost immediately ran off to the right, where the starboard wing struck the fence running parallel to the strip.

Examination of the aircraft after the accident, showed that the nose leg was fully down and locked. The failure of the green 'DOWN' indicator to illuminate was the result of nothing more than a dirty micro-switch.

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Although it would be unfair and unjust to criticise the pilot for his efforts to guard the propellers from damage, it must be admitted that his *modus operandi* in this particular instance left something to be desired.

In fact the dangerous situation that developed would have been avoided if the pilot had refrained from feathering the second engine until after the aircraft was stabilised on final approach, with the desired touch-down point obviously within gliding distance. Then and only then should the second engine have been shut down.

Even if the worst had then come to the worst and the pilot had been unable to complete these actions in time for the touch-down, he would still have had the satisfaction of saving one propeller. And one bent propeller is surely preferable to the extensive damage which the aircraft actually sustained in this case!

The wisdom and effectiveness of following this more conservative procedure is born out by the outcome of another accident which occurred in very similar circumstances at Moorabbin not long ago. This time the aircraft was the Apache's 'big brother', a Piper Aztec, and again the pilot was unable to obtain a safe 'DOWN' indication for the nose undercarriage. But this time as well, a visual inspection from the control tower confirmed that the nose leg was not fully down. It subsequently defied all efforts to get it down, and the pilot was finally left with no alternative but to land with the main undercarriage down and locked and the nose leg trailing midway between the 'DOWN' and retracted positions. All emergency services were therefore alerted, and when all was ready the pilot began his final approach.

'When I was lined up,' he explained afterwards, 'and committed to landing with plenty of strip available, I feathered both engines and had enough time to position the propellers with the starter into a horizontal position.

'I turned the master and magneto switches off and touched down at a slow speed. The landing was smooth and at the last moment the nose dropped, collapsing the nose gear, and the aircraft slid along the grass nose-down. There did not seem to be much damage.'

The accompanying photograph of this pilot's aircraft bears out both the effectiveness of his judgement and the point we are making!

Top: The Aztec after its emergency landing, showing minimal damage which followed collapse of the nose leg.

The Apache after striking the boundary fence during approach with both propellers feathered. Note the severe damage incurred by the starboard wing.