No. 67 MARCH 1970

AVIATION SAFETY DIGEST

DEPARTMENT OF CIVIL AVIATION AUSTRALIA

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Contents

FRONT COVER: Their holidays over, passengers from Whitsunday Island wait to board a Twin Otter at Shute Harbour on the North Queensland coast. The Twin Otter operates a feeder service to Mackay, connecting with interstate jet services to the southern capitals.

BACK COVER: Aerobatic duo: A Beagle Pup and an AESL Airtourer pose in front of the old control tower at Bankstown Airport. The tower, which has served general aviation since the war years and the Tiger Moth era of flying training, is soon to be superseded by a modern building on the opposite side of the airport.—S.J. Cherz photograph.

AUSTRALIA

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VIGILANCE IS VITAL

AN IMPORTANT MESSAGE FOR ALL GENERAL AVIATION PILOTS

A LARGE proportion of the contents of this issue of Aviation Safety Digest is concerned with accidents in which aircraft collided with overhead wires. The circumstances of these accidents are various, but they have been selected as typical of the all-to-frequent situations in which general aviation aircraft are striking power lines in the course of operations in rural areas.

Over the years many accidents of a substantially similar nature have been publicized in the Digest, in the hope that pilots would remember the need to be constantly on the alert for these hard-to-see but highly dangerous obstructions. It is impossible to gauge what effect this publicity has had in the past, but it is clear that the present rate at which accidents of this type are occurring, and the consequent cost in lives, injuries and aircraft cannot be allowed to continue.

Why do so many disturbingly similar accidents go on happening, despite the repeated warnings that have been given? Is it that too many pilots have grown complacent about the hazard of wires—that the well known "it won't happen to me" philosophy sometimes mitigates the taking of adequate precautions?

For instance there was one agricultural pilot, who, having been fortunate enough to remain in flight after hitting a power line, simply shrugged the matter off with the statement that "it was one of the hazards of the game". No doubt this pilot thinks rather differently now because not long afterwards, he again collided with a power line. This time his aircraft crashed and overturned and he was seriously injured.

On the other hand, has the task of always seeing and avoiding the multifarious and ever-proliferating power lines in our country areas become more than can be reasonably expected of any one person? Sometimes, for example, a power line might have been erected on an approach to an intended Authorized Landing Area since a pilot's previous visit, and he might not have been informed of it. Then again, could it be that too much is being asked of agricultural pilots who spend a substantial part of their working lives spraying crops around, between, and sometimes under, difficult-to-see cables? Is it significant that both the pilots involved in the two, very similar accidents reported on pages 3 and 5, were highly experienced in agricultural operations and had excellent safety records? And what of the pilot faced with making an emergency landing on the most suitable looking area available to him? How can he hope to know whether or not there are power lines waiting to snare his aircraft as it approaches to land?

Whatever the plausibility of these arguments, it is an inescapable fact that the final responsibility for the safety of any given task must rest with someone. Where that task happens to be the operation of an aircraft, that final responsibility can only be given to the pilot-in-command. This is a basic, inviolate and proven principle that aviation has inherited from hundreds of years of seafaring experience. Regardless of the particular operational situation in which an aircraft is placed, pilots must recognise this fact and accept it with its full implications. They must realise that the only **complete** answer to the problem of colliding with overhead wires at the present time is still greater vigilance — not only in keeping a sharp look-out while actually in flight but, equally important, in assimilating beforehand all relevant information on the positions of wires in the area of operation.

* * *

The pilot intending to use an authorised Landing Area must never **assume** there are no hidden obstructions in the approach path, just because no one has mentioned them or he has not noticed them. Instead, when making enquiries as to the suitability of the landing area, he must take the initiative in seeking out pertinent information on wires in the area's vicinity.

Even while these words were being written, yet another aircraft collided with a power line while approaching to land at an airstrip in Northern Victoria. The two occupants were seriously injured and the aircraft was written off. The strip, on private property, was clearly marked and had previously been used as an Authorised Landing Area. But unknown to the pilot, a power line had been erected across the approach path which, in effect, meant that the threshold was displaced further into the strip to meet the obstruction-free gradient requirement prescribed in the AIP and the Visual Flight Guide. There were no markings to indicate this fact however, and although agricultural pilots who had used the strip recently were aware of the power line, the significance of its position was not apparent to the owner of the property who had no aeronautical training. The pilot had telephoned the owner before setting out on the flight to obtain his permission to use the strip and to check that it was serviceable. The owner had assured the pilot that it was, but no mention was made of the power line. If the pilot had thought to question the owner directly about wires in the vicinity of the strip, it is most likely that he would have been told about the power line at the approach end of the strip.

Another lesson which emerges from this latest accident concerns the type of approach the pilot made to the strip. Not having landed there before, he thought it best to touch down, as close as possible to the threshold. To do this, the pilot made a long shallow final approach, "dragging" the aircraft in with power, which in this case, placed it directly in the path of the unseen power line. But even where a power line is far enough from the threshold of a strip to conform to the 1:20 obstacle-free gradient requirement for an Authorised Landing Area, an approach of this type could endanger an aircraft by placing it **below** the 1:20 gradient.

* * *

In the same way, the agricultural pilot planning to spray a particular area should not be satisfied that his knowledge of the area is "good enough," just because he has inspected it or sprayed it previously. Compared to the cost of an aircraft and possibly a life, the time and money involved in making another inspection flight to refresh his memory and to familiarise himself with any changes, is infinitesimal. The two very similar agricultural spraying accidents reported in this issue might have been avoided if the pilots concerned had observed this simple precaution immediately before commencing to spray the fields in which they subsequently crashed.

The same philosophy of vigilance can even be applied by the pilot who is unlucky enough to have to "pick a paddock" for an emergency landing. The possibility of wires in the intended landing path is at least as important a consideration as the suitability of the field's surface. A well planned forced landing approach to an apparently suitable field is to little avail if one is going to be unpleasantly surprised by the presence of a hitherto unseen power line too late in the descent! The wiser course, in selecting a paddock in any reasonably developed rural area, is to assume that there **will** be wires somewhere in the vicinity, and to maintain a constant look out for them throughout the descent, using whatever cues there are on the ground to assist in their detection. In this way there should be a much better chance of sighting any wires in time to plan a final approach which will avoid them.

* * *

Nothing that has been said about pilot responsibility should be allowed to mask the fact that more could be done from the ground to assist pilots to avoid wire strikes. The Department is examining this question at the present time, particularly as regards agricultural flying, but in the meantime there is no reason why agricultural operators cannot do more themselves about marking the position of hard-to-see wires while their aircraft are operating in their vicinity. Once again, it is a matter of comparative economics. One aircraft is surely worth many times the cost of marking the position of a powerline in some simple manner.

Similarly, there is no reason why fields used as Authorised Landing Areas, and having power lines in their vicinity, should not contain some marking that would alert pilots to the presence of the wires. One of the difficulties in the way of doing this, as we have already seen, is the fact that some owners of properties on which strips are situated, do not appreciate the danger which wires may pose to an aircraft. For this reason, it behoves all pilots who know of wires in the vicinity of a paddock or a strip used as an Authorized Landing Area, to urge the owner to pass this information on to any pilot seeking permission to use the landing area.

One further consideration that has also been mentioned in a previous issue of the Digest is the "insurance value" of wire cutters and other anti-snagging devices on agricultural aircraft. (See "Is Your Neck Worth Fifty Cents?", Digest No. 64, September, 1969). The fitment of this equipment need carry no stigma or inference that the aircraft is likely to be flown in a less responsible manner than it would be otherwise. And in advocating such devices, the Digest is certainly not suggesting that a lesser degree of vigilance is acceptable when carrying these fittings. But despite all that can and should be done to avoid collisions with wires, it cannot be denied that **some** wire strike accidents will continue to occur. The use of wire cutters and other anti-snagging equipment as a "last ditch" stand against the possibility of a serious, and possibly fatal accident is therefore no more than a sound, common sense practice, and can only contribute to safety.

Finally, let it be stressed that the absence of fatalities in any of the wire strike accidents reported in this issue is no cause for complacency. Clearly, in every instance the consequences could have been far worse, and in the case of the two agricultural accidents, the pilots were lucky indeed to survive. Regrettably, there have been other, very similar accidents since these, in which the occupants have not been nearly so fortunate. —

POWER LINE STRUCK DURING SPRAYING RUN (1)

THE wrecked Pawnee in the picture above was being used to spray a crop of potatoes in Western Victoria, when it flew into a power line.

The pilot had sprayed the same field only the previous day and was quite familiar with the area and the disposition of the power lines which passed through it. Arriving over the field after a twenty-minute ferry flight from his base, the pilot began spraying, making his first run east-west, parallel to and on the southern side of a main power line which crossed the field in the same direction. After completing a second spraying run in the opposite direction, the pilot proceeded to spray a smaller field a short distance away.

Returning then to treat the remaining section of the larger field, the pilot began another east-west run, but this time on the northern side of the power line. Towards the middle of the run, as he was looking back to check the drift of the spray swathe, the aircraft collided with a three wire spur power line which runs north at right angles from the main line. The aircraft pitched down steeply, struck the ground on its nose, bounced and somersaulted in the air, and came to rest on its back. Fire broke out in the engine bay almost immediately. Fortunately for the pilot, who was not able to extricate himself, two farm workers who had been digging potatoes nearby, ran to the site to help him from the burning wreckage, then assisted in extinguishing the fire. The pilot was admitted to hospital with serious injuries.

* * *

View of accident site looking back towards aircraft's direction of approach. The line of poles marking the position of the main power line is on the right of the aircraft. The first pole of the spur line is just out of the picture near the tree at the extreme left.

The pilot was highly experienced and had been engaged in agricultural flying for nine years. He had not previously been involved in a collision with wires. He had flown no more than 25 hours in the seven days preceding the accident and said that on the morning of the accident he was feeling quite fresh.

Nevertheless because the task on which the pilot was engaged at the time of the accident was at first sight a straight-forward one, it is possible that it did not stimulate in him a high level of alertness. The main power line with which the pilot was flying parallel was clearly visible from its prominent line of poles, and was well away from any trees or other masking background. But by contrast, the first pole of the spur power line was much more obscure on the northern boundary of the field, and its wires where they crossed the aircraft's path were anything but prominent. There was thus little in the pilot's visual field to remind him of the presence of the spur line and it is apparent that, while preoccupied with checking the drift of his spray, he simply allowed his vigilance and his concentration on obstructions which he knew were there, to lapse.

Cause

The cause of the accident was that the pilot did not exercise the amount of care needed while flying in the vicinity of power lines.

A close up of the cockpit showing the degree of impact and fire damage.

POWER LINE STRUCK DURING SPRAYING RUN (2)

THE burnt out remains in this picture are those of another Pawnee which struck a power line while crop spraying—this time near Proserpine in Queensland, where the crop was sugar cane.

The pilot took off from an agricultural strip in the area, intending to spray three sugar cane fields in the one flight. The day was fine with excellent visibility, and a light to moderate breeze.

After completing the spraying of the largest of the three paddocks, which he understood to be 28 acres in area, the pilot found to his surprise that the amount of spray he had used was equivalent to only 21 acres. The pilot was expecting the men acting as ground markers to indicate a further area nearby which would make the total up to 28 acres, and he flew in the direction their signals indicated. Instead of finding the further area he supposed was there, the pilot saw only the second of the three paddocks he had been briefed to spray. This paddock was 10 acres in area, and knowing that there were power lines in its vicinity, the pilot took the opportunity to carry out an aerial inspection of the area, during which he made a mental note of the position of the obstructions.

Before commencing to spray it however, the pilot decided to first spray the third paddock allocated to him, consisting of 11 acres of sugar cane, which he knew to be completely free of obstructions. By treating this paddock first, he would be able to reduce the hopper load to the minimum before tackling the obstructions associated with the 10-acre paddock.

Having completed the spraying of the 11-acre paddock, the pilot flew back towards the 10-acre paddock, intending to make his runs west to east and parallel to a two-strand power line which runs along the southern boundary of the field. As he approached the area, the pilot commenced his first run in towards where a marker had taken up his position on the western boundary of the paddock. But just before his aircraft reached this point, the pilot saw the wires of another power line, bordering the paddock's western boundary.

The pilot opened the throttle and raised the nose steeply in an attempt to clear the power line, but the tail wheel caught on the wires. One wire broke but the other stretched and the aircraft decelerated rapidly. The nose dropped, and the aircraft

The cable that arrested the aircraft lying in the groove it wore in the tail wheel assembly.

struck the ground in a nose down, laterally level attitude and burst into flames. The tightly stretched power cable, still attached to the tail wheel, then rebounded, pulling the aircraft backwards some 20 feet. During this fortuitous movement, which momentarily drew the flames away from the cockpit, the pilot hurriedly evacuated the aircraft. He suffered no injuries but the aircraft was completely destroyed by fire.

* * *

The pilot said afterwards that although he was aware of the power line on the southern boundary of the paddock, he had completely forgotten the existence of the wires running north and south across his intended spraying path. The pilot, who had flown over 3,000 hours on agricultural operations, explained that as he lined up for the run on which the accident occurred, he was still preoccupied with the apparent discrepancy in the acreage he had treated and was wondering why the markers from the first paddock had not taken up positions to indicate the additional area to be sprayed.

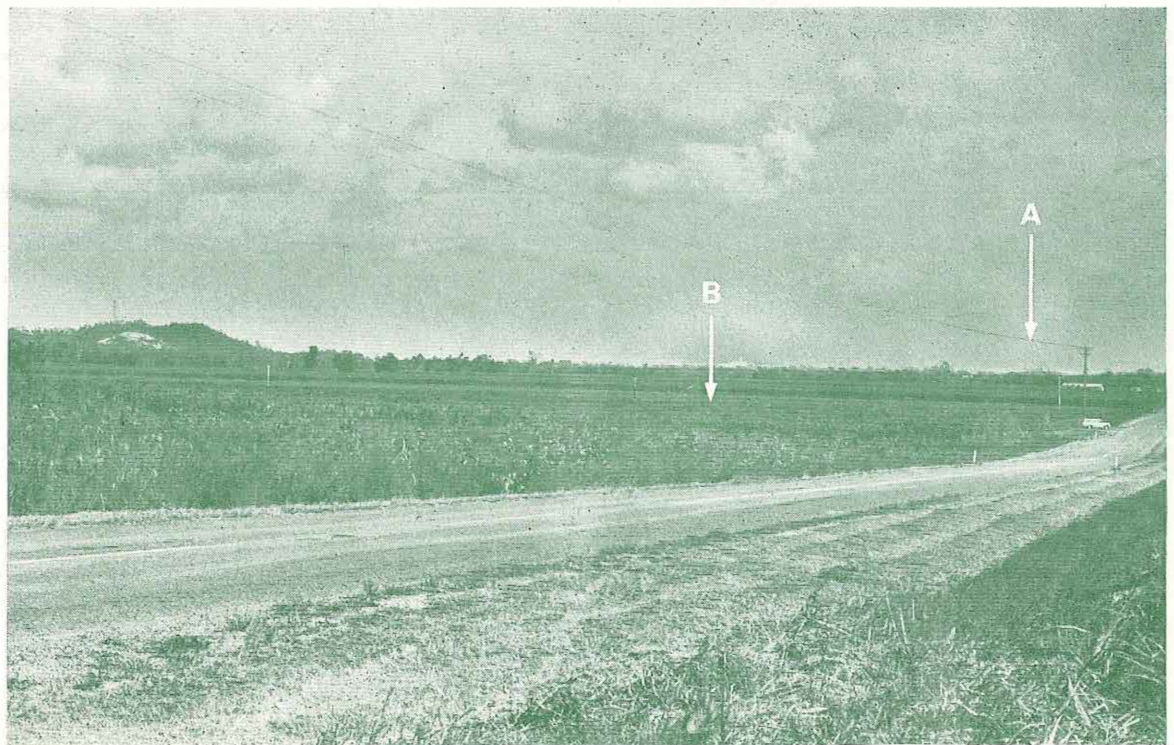
Although the wires which the aircraft hit were not obscured in any way, it is possible that they would have blended to some extent into the background of hills to the east of the area. The power lines on the southern side of the paddock were clearly in evidence because the nearest pole was in the corner of the field close to the pilot's intended initial spray path. On the power line which the aircraft struck however, the nearest pole was nearly 1,000 feet to port of the aircraft and might have been beyond the pilot's cone of vision as he lined up for the first run.

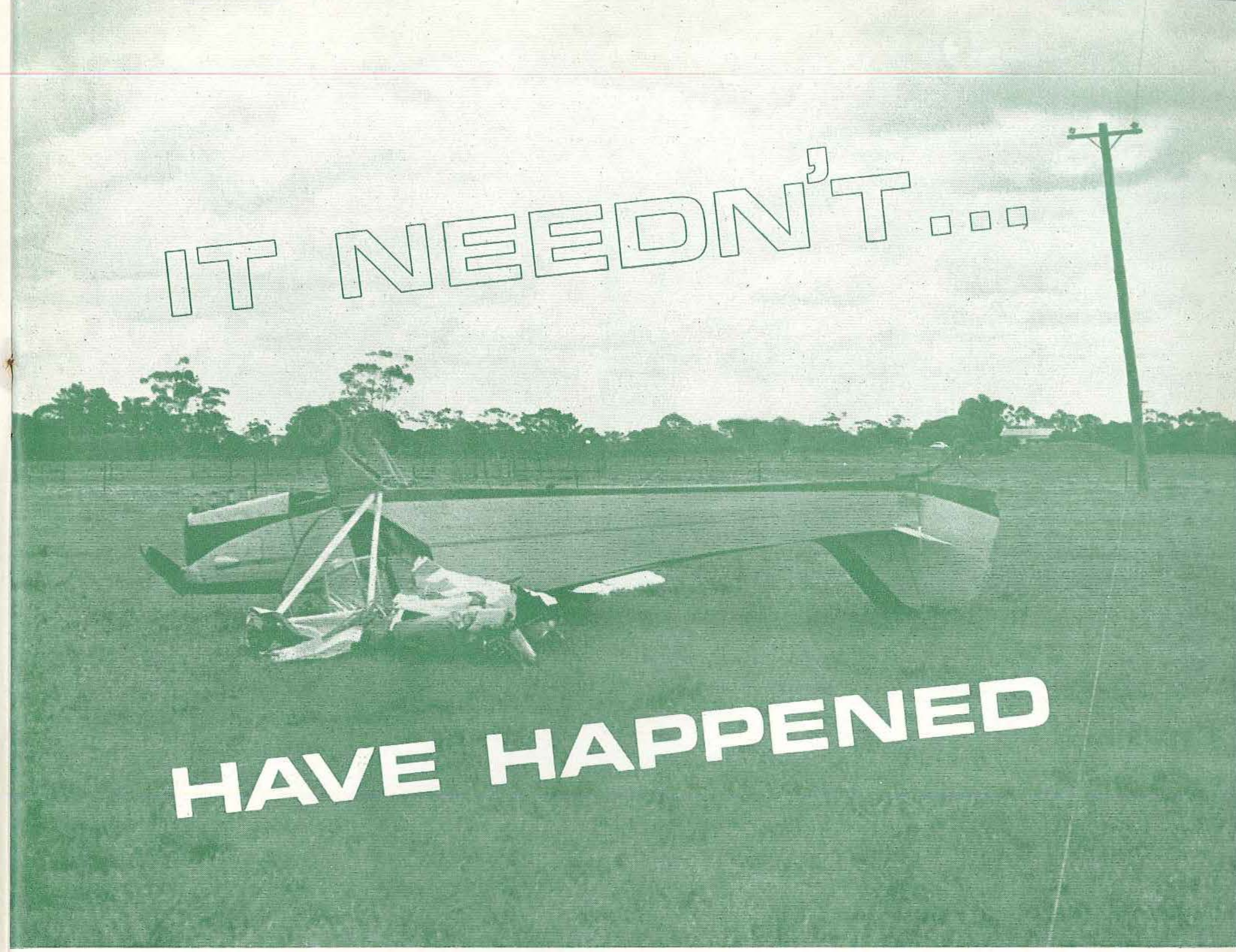
In the circumstances it seems that the pilot, concerned as he was about the apparent discrepancy in the area he was required to spray, was not concentrating sufficiently on his immediate task. In retrospect it seems that it would have been a wise precaution, after completing the spraying of the other field, to have carried out a further inspection of the paddock in which the obstructions were located, immediately before commencing his first run.

Cause

The cause of the accident was that the pilot did not maintain the high degree of vigilance necessary when carrying out agricultural operations at low height in the presence of obstructions. —

View of the 10-acre paddock of sugar came showing "A" point of impact with power line. "B" point of impact with ground. The two-strand power line parallel to the flight path can be seen on the far boundary of the paddock.



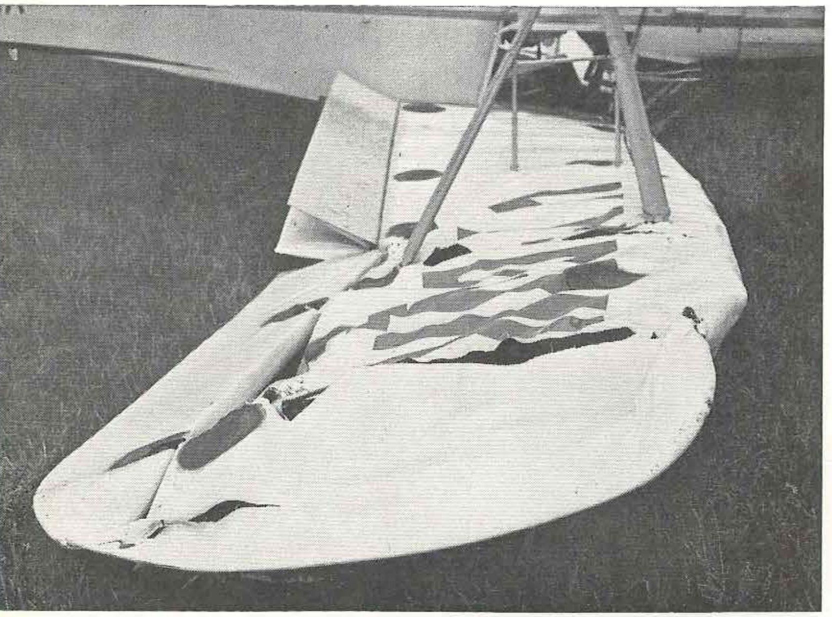


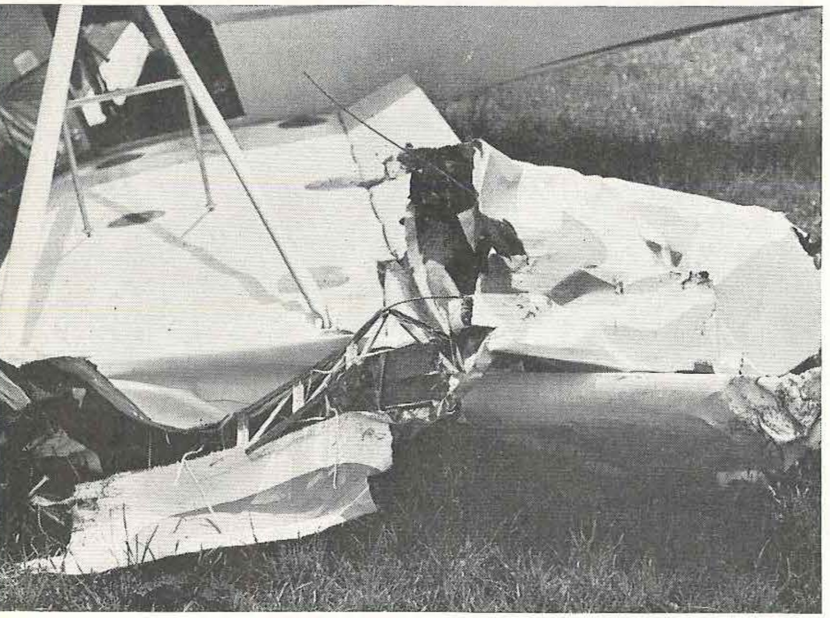
IT NEEDN'T... HAVE HAPPENED

While being flown on a local pleasure flight from a country flying school in southern Victoria, the engine of an Auster Mk III faltered, then failed completely. The pilot manoeuvred the aircraft for a forced landing in a paddock, but on final approach the aircraft collided with an unseen two-wire power line and crashed to the ground upside down. The aircraft was damaged substantially but the two occupants escaped with only minor injuries.

The pilot, who held a restricted private licence, had arranged to take a friend for a local pleasure flight, lasting about an hour, in the Auster. The aircraft was just returning from a solo training flight when the two men arrived at the flying school. As it taxied in, the pilot at the controls saw the others were waiting for the aircraft, so he vacated the cockpit with the engine running to allow the two men to board the aircraft and depart immediately.

It was about 35 minutes after they had taken off that the engine failed. Selecting a paddock that he had previously noted as suitable for a forced landing, the pilot planned a landing into wind. On final approach, just after the aircraft had passed over a house and some trees and the





The damage sustained by port and starboard wing tips when the aircraft cartwheeled.

pilot had lowered the third stage of flap, the aircraft suddenly began to roll to starboard. The pilot attempted to correct the roll but then saw the port wing strut had made contact with power cables running in almost the same direction as his landing path. Despite the pilot's efforts, the wire rode up the wing strut, rolling the aircraft until it was banked almost vertically. The starboard wing then struck the ground, and the aircraft cartwheeled, coming to rest on its back, with the second wire of the power line still hooked on the tail wheel.

* * *

Examination of the aircraft after the accident established that the engine had failed simply for want of fuel. But despite the fact that the aircraft fuel tank was empty, the fuel contents gauge was still indicating four gallons.

It was learned that it was the flying school's practice to refuel their aircraft to capacity at the conclusion of each day's flying. On the day preceding the accident however, the Auster had been flying until last light. As a result, it was almost completely dark by the time the aircraft could be refuelled, and the flying instructor carrying out the refuelling found it very difficult to tell how much fuel was in the tank. Not wishing to overfill the tank with the risk of overflowing fuel into the cabin, the instructor discontinued refuelling when he estimated the tank contained eight gallons. He then entered this figure in the "total fuel" column of the aircraft's Flight Authorisation Sheet.

The following morning, another instructor and a private pilot who were to fly together in the aircraft, carried out a daily inspection of the aircraft but did not physically check the contents of the fuel tank in accordance with the flying school's operational procedures. Instead, knowing that it was customary for the school's aircraft to be refuelled at the end of each day, and seeing that the fuel contents gauge was indicating full, he assumed that the tank had been filled to capacity. After making a 15-minute check flight with the private pilot, the flying instructor authorized him to carry out 45 minutes of solo flight.

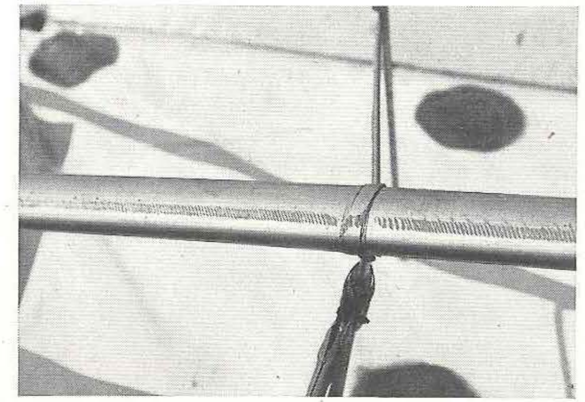
While this flight was in progress, the Chief Flying Instructor happened to notice the figure of eight gallons that had been entered on the Flight Authorization Sheet the night before. He then queried this figure with the instructor who had just flown the aircraft and was told that the tank was full. The C.F.I. therefore assumed that the figure eight on the sheet belonged, not in the "total fuel" column, but in the adjoining "fuel added" column, so he altered the "total fuel" figure to read "full".

By the time the private pilot landed at the end of his solo flight, the aircraft had flown an hour. As already described, it was then taken over by the pilot involved in the accident.

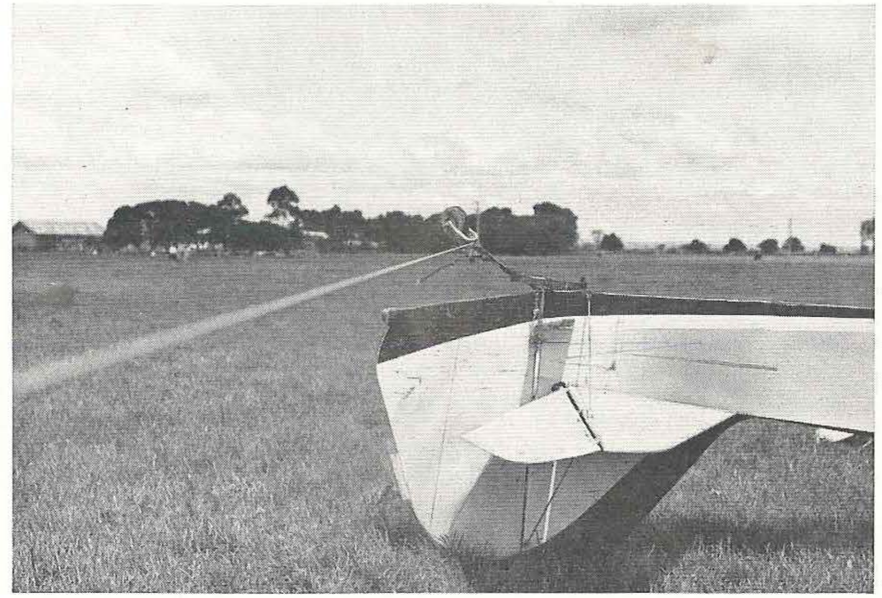
* * *

The sequence of events leading to this accident, as revealed by the investigation, is a further demonstration of the fact that an aircraft accident very seldom results from a single isolated occurrence, but rather from an unfavourable combination or chain of events, any one of which in isolation, might amount to no more than an incident, and which, if acted upon correctly at the time, could probably prevent the accident.

The "evolution" or chain of events leading to this accident is quite plain. The first link in the chain, though in the circumstances it was a legitimate one, was the instructor's departure from the standard practice of refuelling the aircraft to capacity at the end of the day's flying. With hindsight it seems that it would have been prudent for this instructor to have notated the Flight Authorization Sheet to the effect that the aircraft's actual fuel contents was uncertain.



The impact marks of the cable imprinted on the port wing strut.



The second cable of the power line still hooked on the tail wheel of the inverted aircraft.

Next, there was the fault in the fuel gauge which caused it to read full when in fact it contained far less. Then, and far more serious, came the other flying instructor's omission to physically check the tank contents while carrying out the daily inspection of the aircraft before its first flight of the day. Though it does not condone the subsequent actions of the persons concerned, it was undoubtedly this omission that helped to forge the final two links in the chain—the alteration of the Flight Authorization Sheet by the CFI, and lastly the acceptance of the fuel situation by the pilot involved in the accident.

It seems almost certain that had any of the pilots taken the trouble to physically check the fuel contents during the morning's flying the accident would have been avoided.

There is no doubt that, within the flying school concerned, this accident and the events that led to it have had a most salutary effect on adherence to laid down procedures. It is hoped that other pilots and operators who may sometimes feel tempted to "short cut" established drills and checks will take to heart the point it so clearly conveys. The lesson can be applied not only to the physical checking of an aircraft's fuel state during a daily inspection, but to all aspects of aircraft operations where established (and often painfully evolved) procedures have been laid down to ensure the safety of that operation.

Cherokee strikes power line during approach

IN north-western New South Wales, a farmer was flying his Cherokee 235 from his homestead to a property 150 miles away, where his employees and equipment were engaged in harvesting wheat. A strip on the property, aligned north-east, south-west, met the minimum requirements for an authorised landing area, and the farmer had landed his aircraft on it several times in the preceding three weeks. He was also aware of the presence of a two cable powerline which crossed the approach path to the south-western end of the strip, at an oblique angle. The power line was 25 feet above the ground and about 100 feet from the boundary fence of the paddock in which the strip was situated.

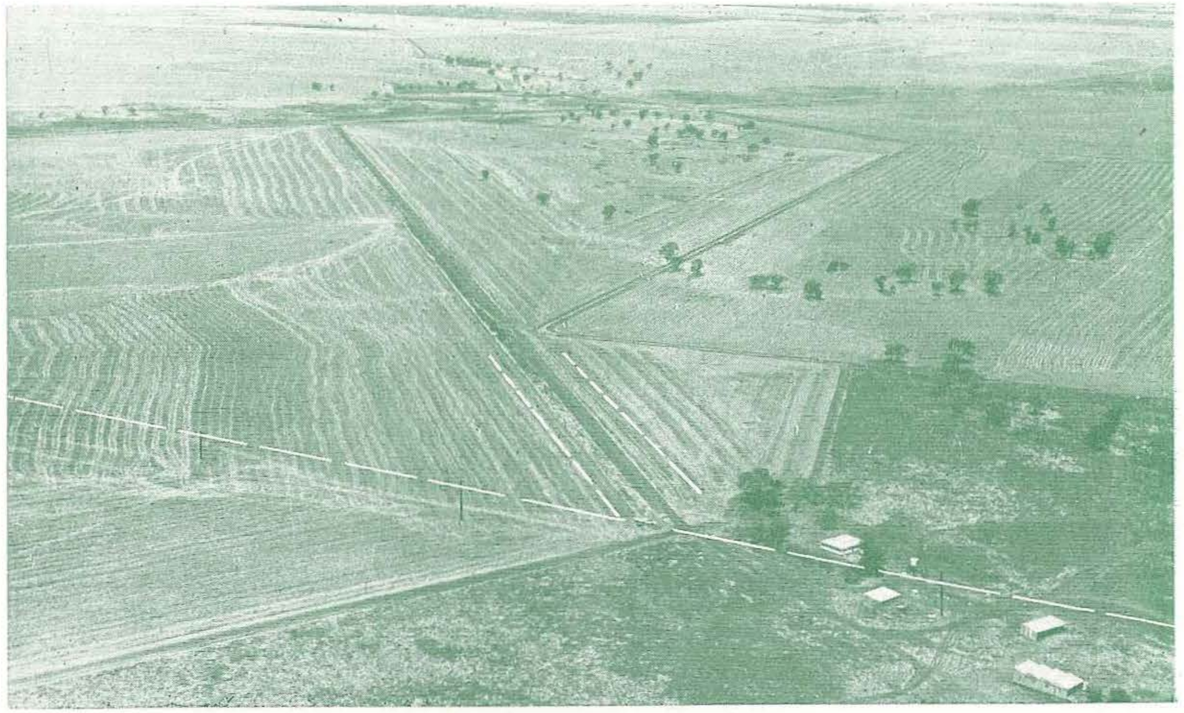
The day was very hot, with a northerly wind, making flight conditions unpleasant in the thermal turbulence and the wind, gusting to 15 knots on the ground, was producing a fluctuating cross-wind component on the strip.

During the pilot's previous landings on this strip the position of the power line had been indicated for him by parking the harvesting machinery beneath the wires, but on this occasion the machinery was not in the area. The pilot flew over the strip, made a left hand circuit and commenced an approach, aiming to touch down about 100 feet beyond the boundary fence. Although he did not actually sight the power line at this stage of the approach, the pilot was intending to clear it by an ample margin.

Closing the throttle and reducing speed to 70 knots, the pilot lowered full flap, intending to further reduce speed to about 60 knots over the fence in order to touch down at the point he had selected. On short final approach, just before the aircraft reached the position of the power line, the aircraft entered a particularly turbulent area and seemed to lose height rapidly. Suddenly the pilot sighted the power line immediately in front of the aircraft, but it was too late to avoid it. The aircraft flew into the wires, decelerated rapidly, and slid to port along the power line. One cable broke, but the other stretched, arresting the aircraft's forward motion as it did so, and the aircraft descended almost vertically to the ground, coming to rest beside the fence bordering the landing area. As the photographs indicate, the aircraft sustained considerable damage to the propeller, undercarriage legs, engine mounting and starboard wing, but the pilot escaped injury.

* * *

Examination of the area being used for the landing showed that, when allowance was made for the position and height of the power line in accordance with the published requirements for authorised landing areas, the position of the threshold should have been 400 feet beyond the boundary fence over which the aircraft was approaching. This "displaced threshold" would still have left a sufficient length of run in the paddock for the operation of a PA.28-235 in the existing conditions. As the pilot intended to park the aircraft near the approach end of the strip however, he was attempting to land "short" to minimise the distance he would have to taxi back to the parking area.

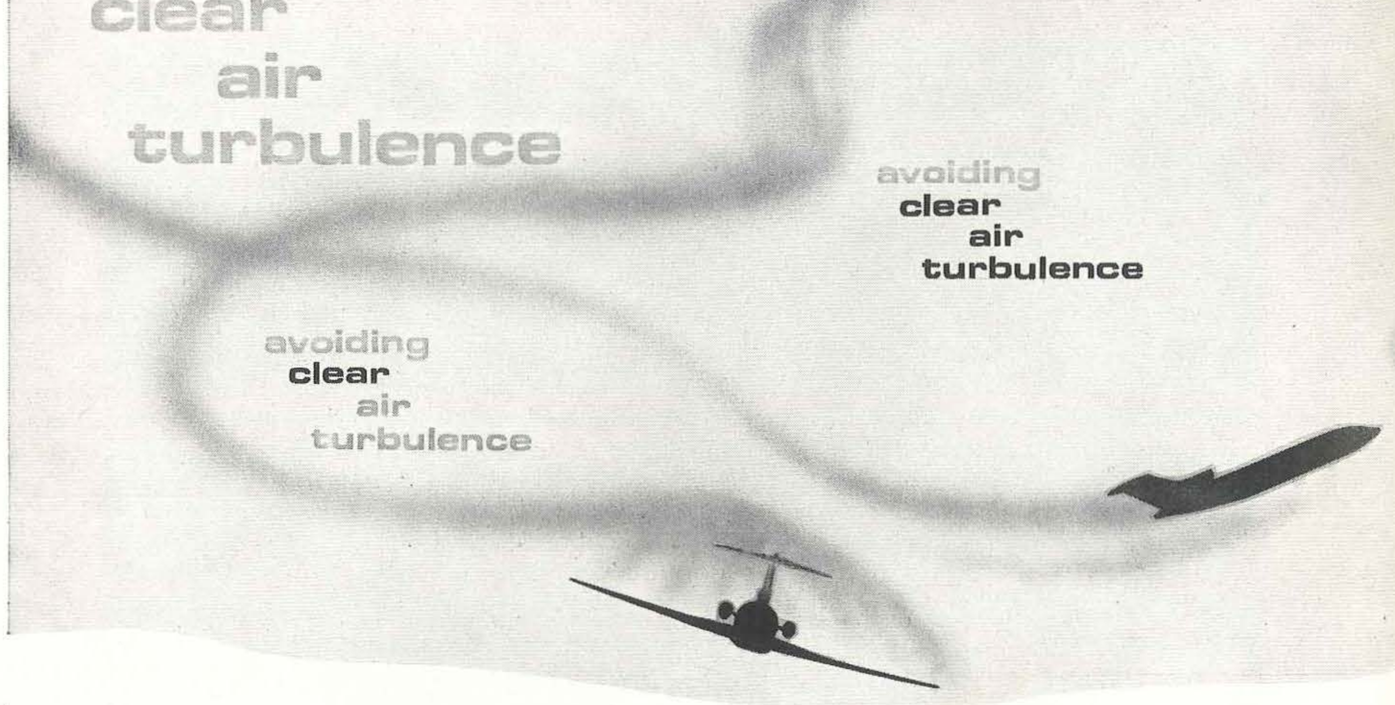


Above: General view of the area showing relative positions of power line and landing strip. Below: The accident site looking in direction aircraft was landing. The repaired power line can be seen in the upper foreground of the picture.

Although the pilot had landed in this direction over the power line several times before, this particular approach differed from the previous ones in one important respect. On these earlier approaches, the harvesting machinery, standing some 14 feet high, positioned beneath the power line, would have provided the pilot with excellent height reference and depth perception. By contrast, on the approach on which the accident occurred, although the pilot knew the power line's general location, he had nothing from which he could accurately gauge its position. No supporting poles were clearly visible from the approach path, and the span of the wires was a long one. In this already difficult situation, which was further complicated by the gusty, hot and turbulent flight conditions, the pilot tried to judge a steep power-off approach to land "short", over where he estimated the obstruction to be. In the circumstances, it would not be exaggerating to say that the pilot was virtually attempting the impossible.

That an accident of some sort occurred in such a situation is hardly surprising. The more unexpected aspect of this particular accident is perhaps the fact that both pilot and aircraft escaped so lightly. The pilot can count himself fortunate indeed the consequences were not far more serious.

avoiding clear air turbulence



CLEAR Air Turbulence has been a problem and a hazard to airline operations since jet aircraft were first introduced to the world's air routes. Before that time, it was generally believed that, with the advent of the large passenger jet, airline aircraft would henceforth be able to cruise in turbulent-free conditions, far above the weather problems that have dogged aviation since its earliest days. It was not until this new generation of aircraft began to operate regularly at jet stream altitudes that the problem of Clear Air Turbulence was fully recognised.

Considering the comparatively few years in which it has been possible to accumulate experience of this phenomenon, it is not surprising that much has still to be learnt about Clear Air Turbulence. Despite the expenditure of considerable sums of money by various governments on research into methods of forecasting and detecting Clear Air Turbulence, no complete solution has been found to these problems. Nevertheless, a lot has been learned in recent years and, at the 6th Air Navigation Conference of the International Civil Aviation Organisation, a paper was presented setting out what it termed some "rules of thumb" for avoiding or minimising encounters with Clear Air Turbulence. These "rules" were subsequently reprinted in a Newsletter issued by the International Airline Navigator's Council in London. The Department believes the advice offered by these "rules of thumb" will be of considerable interest to Australian crews flying jet aircraft.

In commenting on these rules, the Bureau of Meteorology in Melbourne has indicated that they are based on reported wind structures and Clear Air Turbulence relationships which are inevitably simplified in practical application. Thus, while the flight procedures recommended to minimise the risk of an encounter will usually have the desired effect, some exceptions will occur.

Although precise values of the various meteorological factors such as air temperature, wind speed, atmospheric pressure, etc., are stated, the rules can only be taken as indicating the possibility of Clear Air Turbulence. Similarly, while these conditions may represent the necessary minima for its formation, an encounter with Clear Air Turbulence during a particular flight could depend on more than one set of conditions being present. For this reason Clear Air Turbulence would not necessarily be encountered on every occasion that the conditions stated in any one rule are met or exceeded.

It should be noted that these "rules of thumb" have been developed for westerly jet streams.

- Jet streams stronger than 110 knots at the core are apt to have areas of significant turbulence near them in the sloping tropopause above the core, in the jet stream front below the core, and on the low-pressure side of the core. In these areas there are frequently strong wind shears.

- Wind shear and its accompanying clear air turbulence in jet streams is more intense above and to the lee of mountain ranges. For this reason, clear air turbulence should be anticipated whenever the flight path traverses a strong jet stream in the vicinity of mountainous terrain.

- On charts for standard isobaric surfaces, such as 300 millibars, if 20-knot isotachs are spaced closer together than 60 nautical miles, there is sufficient horizontal shear for CAT. This area is normally on the poleward (low pressure) side of the jet stream axis, but in unusual cases may occur on the equatorial side.

- Turbulence is also related to vertical shear. From the winds-aloft charts or reports, compute the vertical shear in knots-per-thousand feet. If it is greater than five knots-per-thousand feet, turbulence is likely. Since vertical shear is related to horizontal temperature gradient, the spacing of isotherms on an upper air chart is significant. If the 5°C isotherms are closer together than two degrees of latitude (120 nautical miles), there is usually sufficient vertical shear for turbulence.

- Curving jet streams are more apt to have turbulent edges than straight ones, especially jet streams which curve around a deep pressure trough.

- Wind-shift areas associated with pressure troughs are frequently turbulent. The sharpness of the wind-shift is the important factor. Also, pressure ridge lines sometimes have rough air.

- In an area where significant clear air turbulence has been reported or is forecast, it is suggested that the pilot adjust the speed to fly to the recommended rough air speed on encountering the first ripple, since the intensity of such turbulence may build up rapidly. In areas where moderate or severe CAT is expected, it is desirable to adjust the airspeed prior to the turbulence encounter.

- If jet stream turbulence is encountered in a cross-wind, it is not so important to change course or flight level since the rough areas are narrow across the wind. However, if it is desired to traverse the clear air turbulence area more quickly, either climb or descend after watching the temperature gauge for a minute or two. If temperature is rising, climb; if temperature is falling, descend. Application of these rules will prevent following the sloping tropopause or frontal surface and staying in the turbulent area. If the temperature remains constant, the flight is probably close to the level of the core, in which case either climb or descend as convenient.

- If turbulence is encountered in an abrupt wind-shift associated with a sharp pressure trough line, establish a course across the trough rather than parallel to it. A change in flight level is not so likely to alleviate the bumpiness as in jet stream turbulence.

- If turbulence is expected because of penetration of a sloping tropopause, watch the temperature gauge. The point of coldest temperature along the flight path will be the tropopause penetration. Turbulence will be most pronounced in the temperature-change zone on the stratospheric side of the sloping tropopause.

- Both vertical and horizontal wind shear are, of course, greatly intensified in mountain wave conditions. Therefore, when the flight path traverses a mountain wave type of flow, it is desirable to fly at turbulence-penetration speed and avoid flight over areas where the terrain drops abruptly, even though there may be no lenticular clouds to identify the condition. ➡

DRILL... and be safe

by Alan Bramson

The following article was originally written for the Private Flying pages of Flight International, in the United Kingdom. We have no doubt that some of our readers have already seen it in that well-known aviation periodical, but because its message is also most pertinent to general aviation safety here in Australia, we believe it should be 'required reading' for all our light aircraft pilots.

We are grateful to the Editor of Flight International for permission to reprint the article in Aviation Safety Digest.

IF it takes two to start an argument do you have to be involved with someone else to have a flying incident, or can you go it alone? To what extent could some of the accidents of the past have been avoided? These are questions which can only be answered with a lot of qualifying "buts" and "ifs". Nevertheless, serious failure of the airframe and acts of God apart, I believe that many of the incidents we read about could have been avoided.

One must, of course, bear in mind that decisions and the actions that follow them are often influenced by the stress of the moment: the procedure one would advocate while discussing a hypothetical situation within the security of that favourite easy chair may become something quite different when the unexpected and horrible occurs. Over the years most of the situations have been countered by drills—vital actions before take-off to avoid getting airborne with the fuel off; downwind checks to prevent wheels-up landings; and rather more dramatic action in event of fire.

But some incidents really are beyond comprehension. There was the relatively inexperienced pilot who took off and attempted to land at an airfield on the South Coast after being warned that the weather was clamped. Only a few fields away from the airport both he and his passenger were killed. A needless and futile waste of life. Then there was the very popular but hopelessly unpredictable little man in the Midlands who arrived at the works flying club after the CFI had left and just as the aircraft was being tied down for the night. Having a PPL and being rather persuasive he managed to talk his colleagues into letting him take off for a quick circuit with a factory mate as passenger. Off they went, only to leave the circuit hell-bent on beating up someone's house in the nearby town. It was getting dark, the pilot had never flown at night, the aircraft had no lighting of any kind, and in any case there were no night landing facilities at this particular airfield. On the approach they hit a tree and the flames could be seen for miles around. Without doubt this is an accident that should never have happened.

In a quite different category are incidents that occur as a result of wrong procedures: setting an incorrect QFE at night and landing short of the field (remember the one that did a perfect landing in a game reserve?), running out of fuel for one reason or another; not recognising carburettor icing until it is well developed, followed by misuse or mistrust of the hot air control because first application makes the engine run even worse.

Of course, not all accidents are the result of pilot trouble. There was the recent case of a businessman who by prior arrangement landed at a disused airfield. Lined up for take-off, he noticed two distant specks moving fast towards him on either side of the runway. Soon these specks became recognisable as two motor cyclists obviously having a race in the eyes-down position. Surely they had seen him? Surely they would stop? No, they did not see him: and no, they did not stop—that is, until one of them had ripped a wing clean off our friend's near-new Jodel DR250. A headache for the two young servicemen's commanding officer, because they had no right to be on the airfield.

In these enlightened days it is unbelievable that people should come to grief as a result of stalling and spinning into the ground, yet still it goes on. Part of the trouble lies in the fact that many modern light aircraft are reluctant to spin and, unless the nose is held high on the horizon, give only token indications of a stall—which at, say, 2,000 ft. means little or nothing to the pilot. But when it happens near the ground then and only then do they realise how fast the ground is coming up to meet them. Again, many private pilots (and even some instructors) believe that a spin is possible only after the aircraft has stalled, when in reality it is at this stage less likely to spin because the rudder has run out of steam and is incapable of producing enough yaw to start autorotation. Remember, it is yaw at low airspeeds that manufactures spins: and a bootful of rudder applied some 5-10kts above stalling speed is just about ideal. With most incidents in flying you get a second chance—i.e., the opportunity to carry out the correct recovery action. Now, provided the symptoms are recognised (and far too many pilots do not understand spin conditions as well as they should), prompt action will prevent full development with very little loss of height: and it should be within the capabilities of every amateur pilot to recover from a stall without losing more than 50 ft. How much height do you lose? Try a stall and recovery next time you fly; you may be in for a surprise.

Again, there are those misjudged forced landings without power. What goes wrong on the very rare occasions when an engine stops? There are, of course, a number of opportunities for error; poor choice of field; forgetting to turn off fuel and ignition when attempts to restart the fan have failed; forgetting to trim-out at best gliding speed, so that height is needlessly dissipated; and—very important—incorrect choice of a 1,000 ft. point, or very often no choice at all because the value of a 1,000 ft. point is not understood.

Engine out—literally

While on the subject of forced landings there is the incredible tale about the late Robin Lindsay-Neale, one-time test pilot for Boulton Paul. On this occasion he was delivering a new light aeroplane to a French customer for another manufacturer. Very sensibly combining business with pleasure, he had with him his wife and, I believe, a sister-in-law and two little children. Shortly after crossing the Channel the aeroplane started to vibrate in a most violent fashion. "I think we have engine trouble," said the test pilot. Now this was the understatement of the year, because the engine had by now dropped out of the airframe—mountings, cowling and all — and was shortly to bury itself into the green fields of northern France. About half-way around the ensuing uninvited loop the two children were bundled from the rear to the front seat and, with the c.g. partly restored, Lindsay-Neale pulled off a classic forced landing without further damage and undoubtedly without power. Here you have the case of a man who could cope with a situation such as this; yet some years later, when a pilot from South Wales had the prop come off an aircraft of the same type, his attempted forced landing reduced it to so much matchwood, though without, incidentally, hurting the pilot.

Finally, there are the "fumble factors" like weakening the mixture control instead of opening the throttle during an overshoot (yes, this has happened too!). In the incident I have in mind this error in itself need not have proved serious because there was plenty of airfield ahead. But the pilot spun-in while attempting to turn back, didn't recognise he was in a spin and therefore took no recovery action, then lay among the wreckage dripping in petrol with the ignition switched on. Happily he is still more or less in one piece and will no doubt fly again.

These are but a few examples of accidents, some unavoidable but successfully countered, others due to incorrect procedures following an unscheduled incident. Bearing in mind that the element of surprise is so often a feature of these cases—what, then, is the answer? The answer is DRILLS. Learn them, practise them, take a pride in them and, above all, don't be afraid of them. ——→

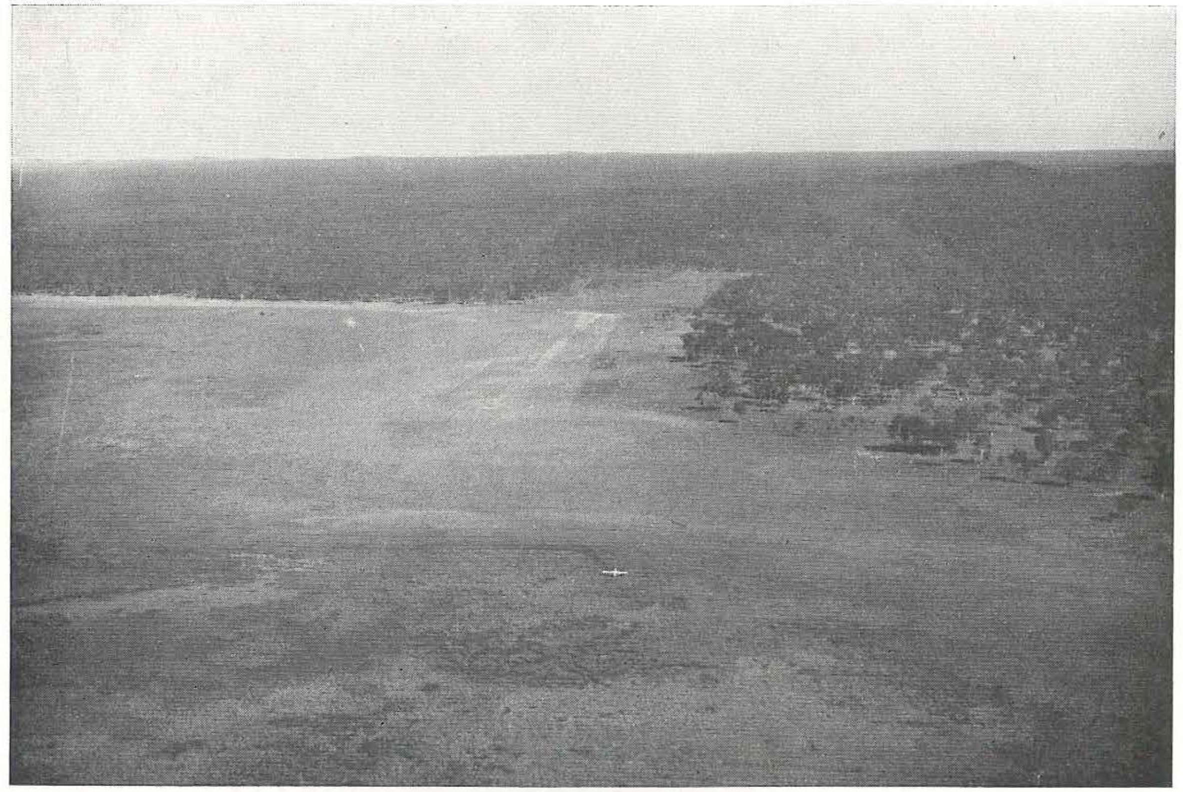
THE ODDS WERE STACKED

IN Northern Queensland, a Cessna 205 had been chartered to pick up three passengers from a station property. The commercial pilot who was rostered to make the flight had been informed by his chief pilot that the strip was about 3,000 feet long with reasonably good approaches.

After an uneventful flight, the pilot arrived at the strip and his three passengers embarked. They proved to be two very big men and a third man of more than average weight. With the passengers on board the aircraft was only 25 lb. below its maximum take-off weight, but although the day was warm with an outside air temperature of 78°F (25°C), the pilot did not anticipate any difficulty in becoming airborne in the distance he believed was available.

The wind was blowing from the east at about five to eight knots, and after starting the engine, the pilot taxied to the western end of the strip, checking the magneto switches and the propeller pitch control and completing his pre-take-off checks as he did so. Reaching the western end of the strip, the pilot turned the aircraft around to line up and began the take-off from a rolling start. Almost immediately he felt that the aircraft was not accelerating normally but, as the manifold pressure gauge, tachometer and fuel flow gauge were all indicating normally he continued the take-off. Soon afterwards, the pilot realised that although the aircraft's speed was still insufficient for take-off, it was too late to abandon the take-off without colliding with the fence. Because the area beyond the fence was clear of all obstructions for more than a mile, the pilot believed that provided he could clear the fence he could safely continue

The nosewheel fork was sheared off when the holding bolts fractured as the aircraft ran into the swamp.



The aircraft where it came to rest after running into the swamp. The aircraft's tracks through the mud can be seen leading from the firm ground in the centre of the picture. The strip is in the middle distance.

in flight even if the rate of climb was poor. The pilot began selecting 20 degrees of flap to assist the take off and at 60 knots with the fence approaching rapidly, he rotated the aircraft. Although it became airborne and began to climb, the main undercarriage struck the top strand of the wire fence, breaking it and bending two fence posts. The impact slowed the aircraft and as the ground ahead was clear the pilot decided the safest course was to abandon the take-off. Lowering the aircraft back on to the ground with power, the pilot saw an accident was inevitable and cut the switches and pulled the mixture control to idle cut-off. The aircraft continued on into soft swampy ground, which snapped off the nose-wheel above the fork, and came to rest smoothly with its nose embedded in the mud. The pilot switched off the fuel and the occupants left the aircraft.

* * *

During the investigation of the accident it was found that the actual length of the strip was only 2,300 feet, or 700 feet shorter than the pilot had been led to believe. For the existing meteorological conditions and the aircraft load, the performance chart for the aircraft type shows a required distance of 2,300 feet for a take-off to a height of 50 feet. To achieve this performance however, the chart stipulates the use of 20 degrees of flap.

In the case of this take-off, the pilot did not begin to extend the flaps until the aircraft had used well over half of the strip and it became obvious to him that there was some doubt of clearing the fence at the end of the strip. Later examination of the aircraft showed in fact that the flaps were extended to only eight degrees. As the pilot had switched off the aircraft's electrical power very shortly after the fence had been struck, it is very probable that the flaps were never more than eight degrees down at any time during the attempted take-off.

As it turned out, there was no evidence that the pilot had actually consulted the performance chart incorporated in the aircraft's flight manual before commencing the take-off on which the accident occurred. In fact it appeared doubtful whether he had given very much thought at all to the conditions under which the take-off would have to be made. It was found after the accident that the pilot believed the strip to be 1,200 feet above mean sea level whereas it was actually 2,100 A.M.S.L. In view of the load which the heavy passengers would obviously have imposed on the aircraft, and the nature of the operation from a bush strip at comparatively high elevation with the temperature standing at nearly 80°F, it is difficult to understand how a commercial pilot, well experienced in such conditions, could have adopted such a complacent attitude to the take-off. Whenever an operation is being conducted from a bush strip at near maximum weight in high density altitude conditions, it is clearly sound practice to make the most of the available length by positioning the aircraft as close as possible to the downwind end of the strip and selecting the recommended take-off flap setting, before power is applied for take-off.

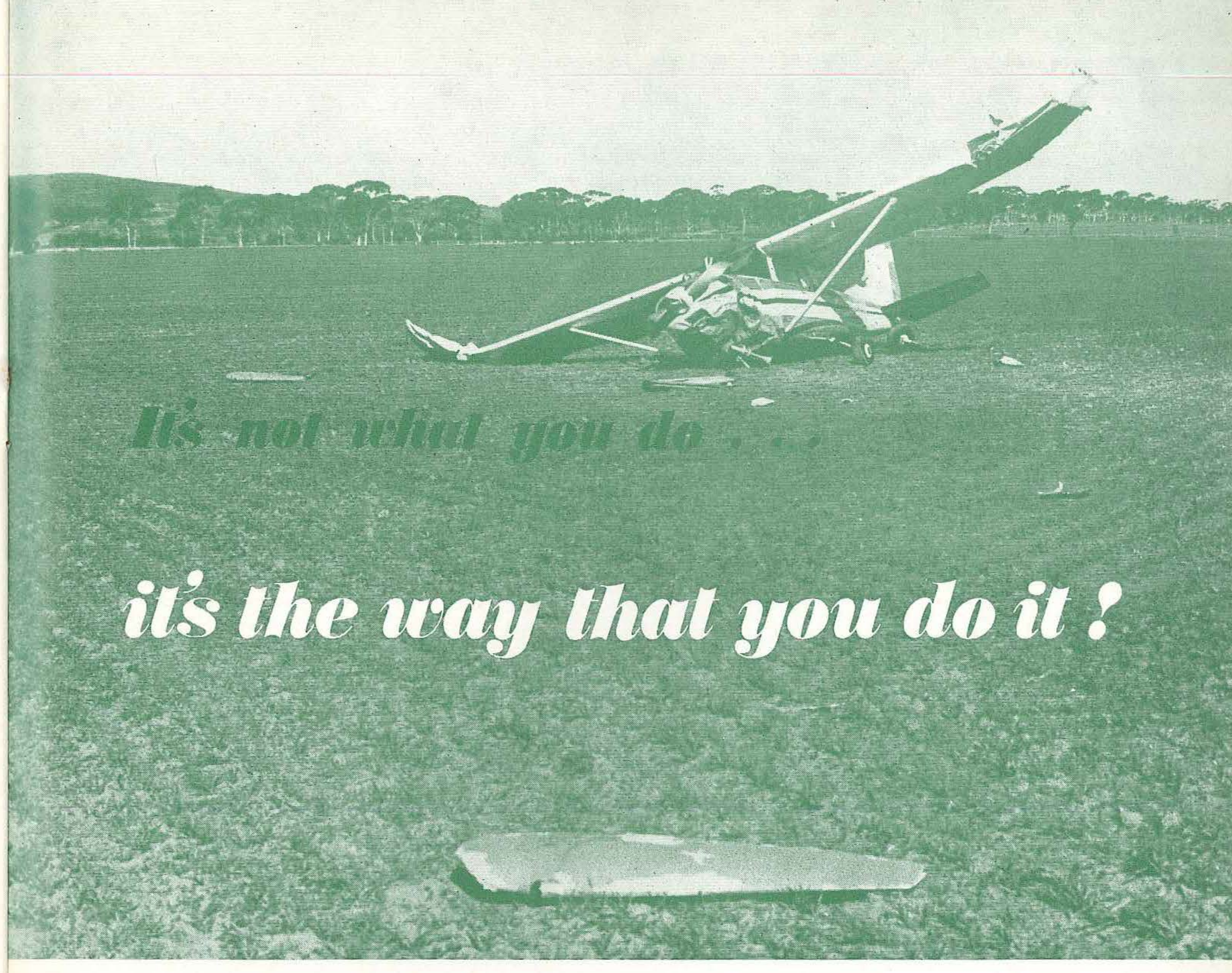
The fact that the pilot did not follow the technique laid down in the aircraft's Flight Manual for obtaining the optimum take-off performance from his aircraft can only be ascribed to the fact that he believed the strip to be 700 feet longer than it actually was. As a result, he expected there would be more than enough length in which to complete a successful take off. In this, he was misled by his chief pilot, who must therefore bear some of the responsibility for the accident. It is not known from what source the chief pilot obtained the figure of 3,000 feet, but this pilot had himself landed on the strip and if the figure was an estimate, it was certainly an optimistic one.

In discussing other take-off accidents of this type, the Digest has frequently warned pilots against the dangers of accepting non-expert opinion on the alleged suitability of bush strips. It was never expected however that such words of caution should have to apply to advice given by chief pilots!

Cause

The cause of the accident was that the pilot was provided with incorrect information regarding the length of the strip.

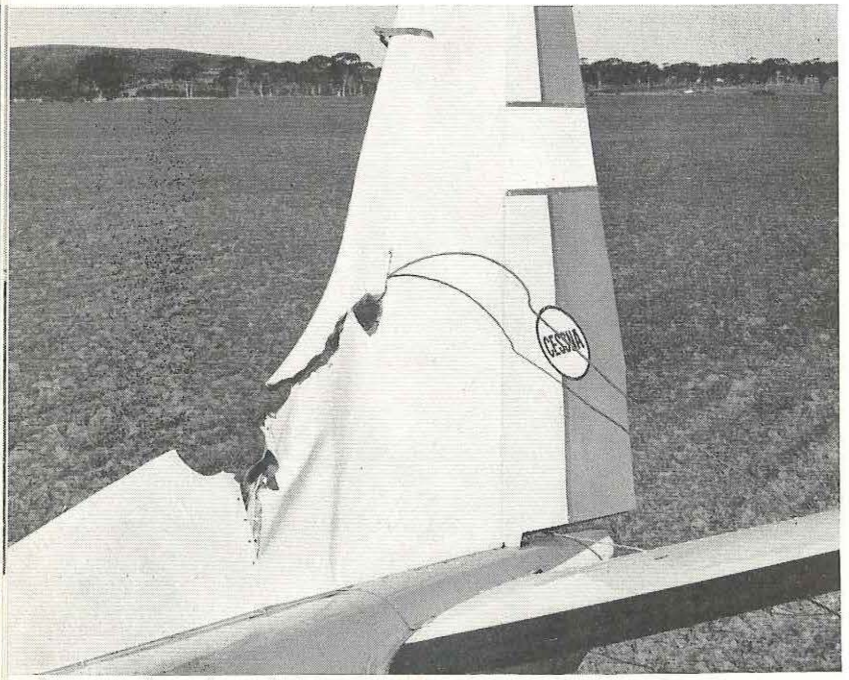
This photograph, taken looking in the direction of take-off, shows the obstruction-free area over which the aircraft would have been able to climb if it had cleared the fence. The end of the strip and the fence can be discerned at the bottom of the picture. The aircraft is at the edge of the swamp near the centre of the picture.



It's not what you do . . . . it's the way that you do it !

THE battered Cessna 182 shown in the photograph came to rest in the manner indicated at the conclusion of a business flight with three passengers, from Jandakot, Western Australia to Merredin, some 130 miles to the east. Before leaving Jandakot, the pilot had ascertained that the Merredin Shire landing area, which comprised two gravel strips of more than adequate length for operation of his aircraft, was situated approximately four and a half miles south-east of the town. The flight from Jandakot was uneventful and when the aircraft arrived over its destination, the pilot duly located the landing area. After circling the general area several times, the pilot decided that as no prior arrangements had been made to transport the party from the aerodrome to the town, he would look for a paddock nearer the town and, if a suitable one could be found, land there.

After investigating several paddocks from the air and finding them all unsatisfactory, the pilot became discouraged with his search and turned the aircraft back towards the Shire landing area. Just as he began to head in this direction however, he noticed a field only a mile and a half north of the town which appeared to be suitable for his purpose. He decided to make a low run over this field to inspect its surface and, after flying parallel to the proposed landing direction for the length of the field at 700 feet, he commenced a 180 degree descending turn to port intending to recover at a height of 20 or 30 feet and fly back over the area at this level.



The power cable embedded in the fin of the wrecked aircraft.

Almost immediately the pilot had recovered from the turn, only 20 feet above ground, the aircraft flew into high tension power lines which neither the pilot nor his passengers had seen. There was a brilliant flash from the port wing and the windscreen shattered as three wires were torn from the two nearest poles, 900 feet apart. The aircraft continued in flight, but yawed to the left and began to descend towards the corner of an adjacent paddock. As it did so, one wire slid up over the mainplanes and became embedded in the fin, causing the nose to pitch up sharply.

Struggling with the controls in an effort to straighten the aircraft and level the wings the pilot applied power and managed to retain some control but he was unable to check the aircraft's descent. The engine and port wing struck the ground heavily, bending the wing upwards outboard of the lift strut, and dislodging the nose wheel. The aircraft then swung around on to the starboard wing and tailplane. The starboard undercarriage leg was torn away and the aircraft slid to a halt facing back the way it had come. Fortunately all four occupants escaped with only minor injuries, but the aircraft was damaged beyond repair.

* * *

It was learned after the accident that for some time past the pilot had quite regularly operated his aircraft from paddocks, both on his family's property and other properties in country areas. Notwithstanding this experience, the standards of airmanship and flying that he displayed on this occasion were anything but those expected of a responsible and apparently mature owner-pilot.

It was abundantly clear that the pilot had not studied the approaches to the boundary of the intended landing area while he still had sufficient height to do so during his initial fly-past at 700 feet. A later examination of the site showed that the poles in the vicinity of the selected threshold were clearly visible from the air when a proper search was made. Instead, during his initial inspection run, the pilot apparently concentrated his attention only on the surface features of the field itself and on some trees along the far boundary. His action in making a descending turn from a height of 700 feet, anticipating a recovery at about 30 feet above ground level then reduced to a minimum any opportunity he might have had to detect the obstructions in the area of the threshold. Manoeuvring an aircraft close to the ground requires a high degree of judgment and concentration at any time and no pilot can expect to be able to devote much attention to checking for possible obstructions while preoccupied with controlling an aircraft in this way. In addition, in this case the restriction to the pilot's vision, caused by the wing during the turn to port, would have effectively prevented him from studying the area along his intended approach path.

It was also determined after the accident that, with the wind blowing at the time, the aircraft would have been affected by a down-wind component increasing to about eight knots during the latter stages of the turn. This factor would undoubtedly have placed the recovery from the turn closer to the selected area than the pilot intended and further reduced any chance he might have had of sighting the power lines in time to avoid them.

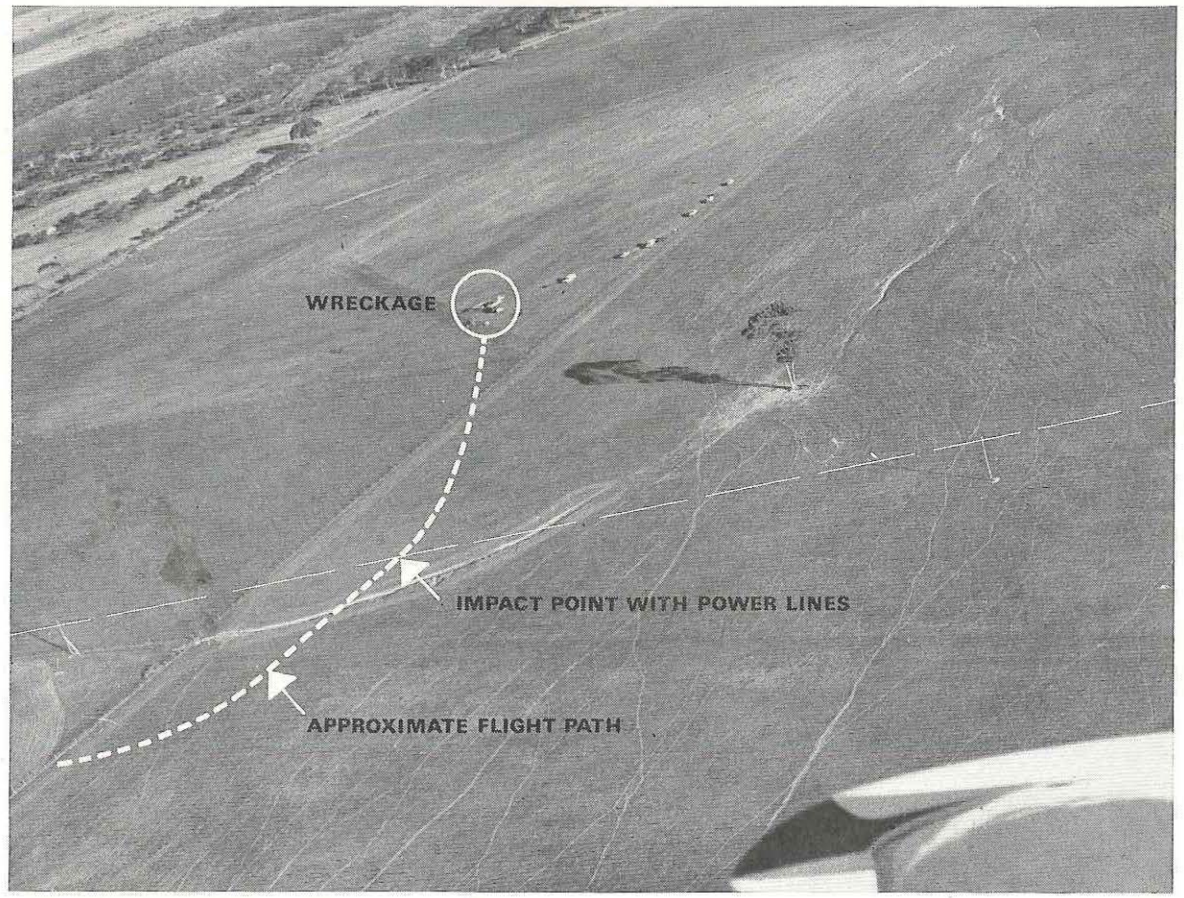
Despite the fact that the pilot's inspection of the approaches to the landing area was inadequate during his initial fly-past, he would have had ample opportunity to concentrate on looking for obstructions while he was still in a position to take avoiding action, if he had flown a proper base leg and a normal descending approach to the field. It is difficult to escape the conclusion that the manner in which the pilot went about his field inspection was foolhardy in the circumstances, and that this accident could have been prevented had the pilot observed normal standards of flying and airmanship.

Comment

The perils of "landing anywhere" have provided the basis for many previous Digest articles and this accident contains a number of familiar lessons. Although in this instance the pilot went through "the motions" of checking for obstructions in his intended landing path, the way in which he went about it denied him the opportunity to conduct a detailed and systematic inspection, a fact which is only too clearly reflected in the outcome of the exercise. Furthermore, as it is hardly necessary to point out, in common with nearly all previous accidents of this type, the owner's permission to use the field as specified in AIP Section AGA-4 and the Visual Flight Guide had not been obtained. Apart from the legal aspects of such a situation, the neglect of this requirement in itself denies a pilot the opportunity to obtain information that could conceivably prevent an accident.

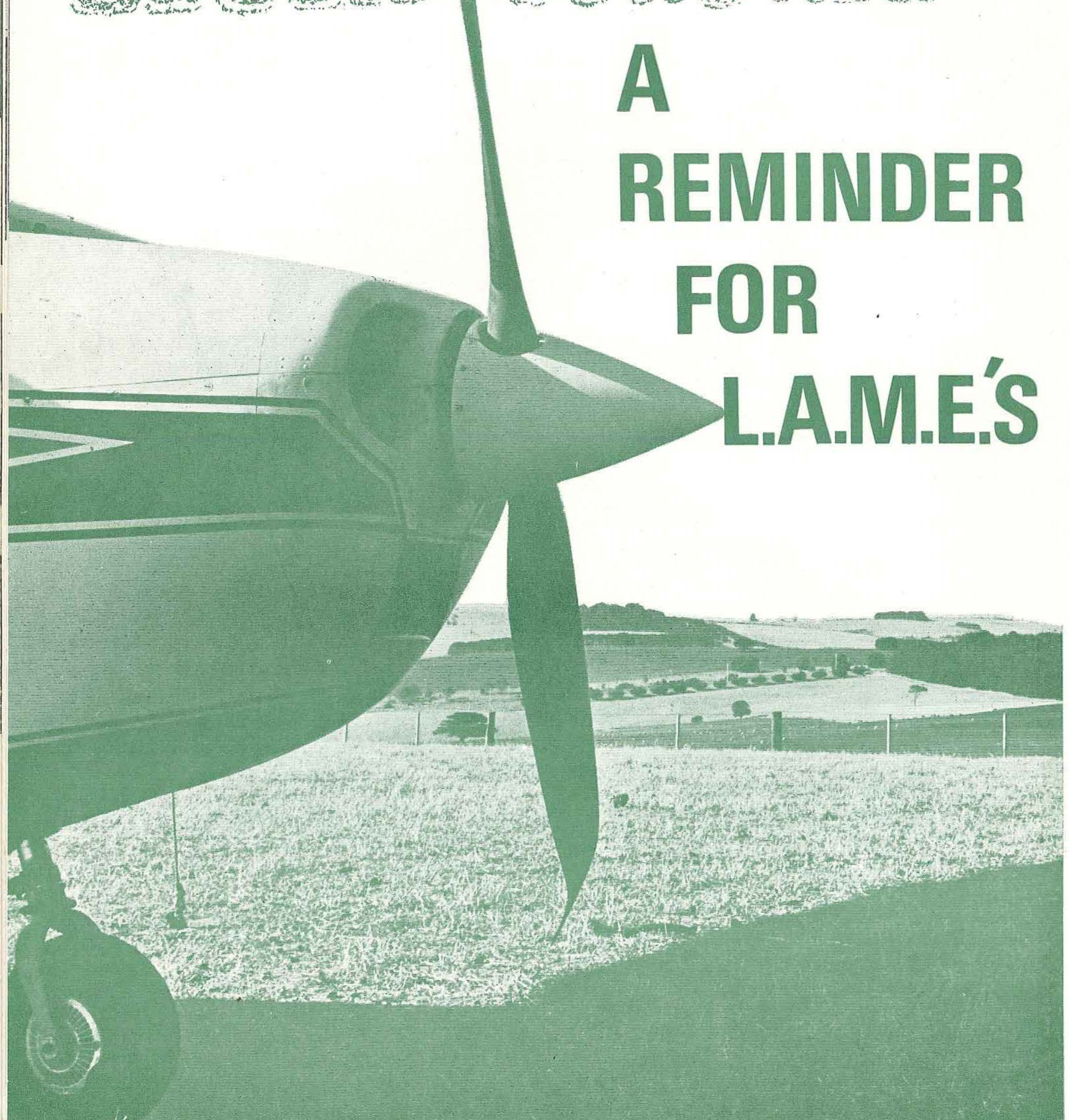
As the aircraft was being affected by an increasing tail-wind component during its turn back towards the "strip" threshold, this accident also provides a timely reminder of the hazards of low-level turns when wind conditions are other than light and variable. Most pilots will be familiar with the common illusions of slipping or skidding, created by drift during low level turns, but it must be remembered that while these apparent effects **are** only optical illusions, the drift itself is very real. Although on this particular occasion the wind was not especially strong and its effect on the radius of turn was probably small, pilots must take every care to ensure that, in winds strong enough to produce drift, plenty of room is available when turning close to the ground in the vicinity of obstructions or rising ground.

Aerial view of accident site showing flight path and position of power line. The pilot intended to make a low pass over the area immediately to the right of the fence running diagonally through the centre of the picture.



SHOCK LOADING

A REMINDER FOR L.A.M.E.'S



NOT infrequently, light aircraft are involved in minor accidents in which the propeller comes into contact with the ground while the engine is running. Such mishaps occur in most cases at air-strips and landing areas in the country when a nose-wheel type aeroplane taxis into an area of soft ground and the nose-wheel sinks, or when the nose-wheel falls into a depression in the ground hidden by long grass. The same sort of thing has of course, occurred at odd times at licensed aerodromes, when a pliot has unwisely decided to take a "short cut" through an unserviceable or unmarked area.

Naturally, whenever such a mishap occurs, the propeller becomes the focus of attention for any damage that might have been inflicted and some propeller damage nearly always results. It is important to remember however, that damage resulting from a propeller contact with the ground may extend far beyond that indicated by the damage to the propeller itself, and can involve structural distress in the airframe as well as internal damage to the engine.

Fatigue Failures

Propeller contacts with the ground have, for example, caused serious damage to engine mountings and have resulted in thrust line misalignments. In small engines also, accelerated fatigue failures of crankshafts have developed from small cracks, initiated by the propeller striking the ground, in case-hardened or plated surfaces of the crankshaft. Cracks of this type are usually very small, but their stress concentrating effects are such that a fatigue failure can result only a matter of several hours of engine time after the initiation of the crack.

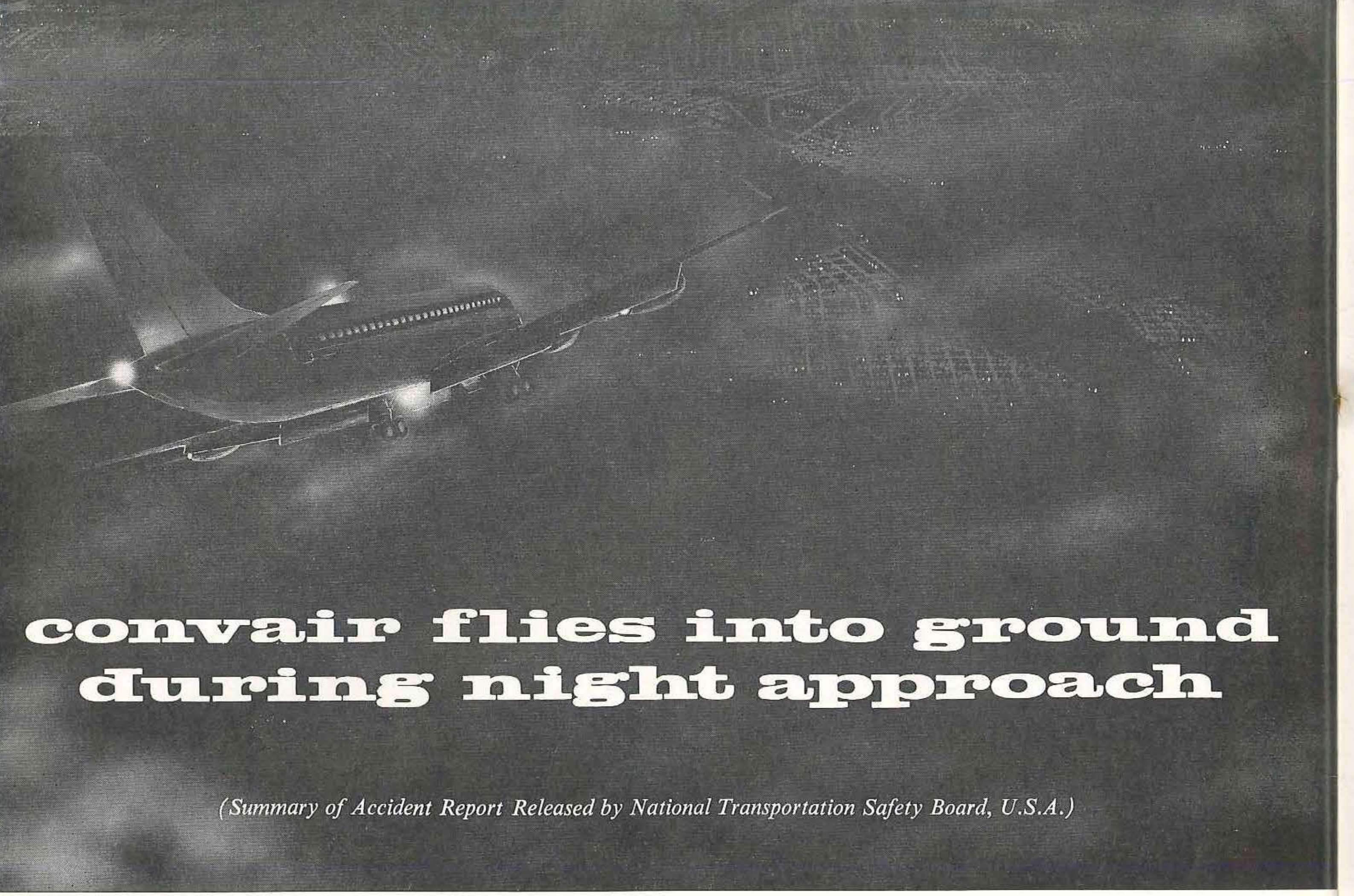
But engine damage likely to result from propeller contacts with the ground is not confined to the crankshaft. During a 100 hourly inspection of a Cessna 210, a crack was found to have developed adjacent to the engine breather at the front of the upper section of the crankcase. When the engine was dismantled, extensive cracking was found to have developed in both halves of the crankcase around the housing for the front main bearing. It was then learned that since the engine's last overhaul, the aircraft had been involved in two mishaps in which the propeller had been bent when it struck the ground. Although in this case no defects could be detected in the crankshaft when it was subjected to a magnetic particle inspection, it was quite evident that the cracking of the crankcase had resulted from shock loadings imposed by the propeller's several impacts with the ground.

Another interesting example of the effects of shock loading emerged during the investigation of a helicopter accident some months ago. The accident had occurred when the tail rotor drive failed in flight. This failure was finally attributed to shock loading cracking and fatigue resulting from the tail rotor striking a grass tussock some time before the accident. Possibly the most significant point brought to light during this investigation was the fact that, although it was the tail rotor strike that initiated the damage, the light metal tail rotor blades had suffered no apparent damage at the time.

Judgement Necessary

Obviously it is not possible to set out clearly defined rules to cover every situation in which an inspection has to be made after a propeller or rotor ground strike. Rather, Licensed Aircraft Maintenance Engineers must use their own engineering judgement to assess how far they should proceed with such inspections. But because the damage involved in accidents of this type is often far more severe than it first appears, instructions given in propeller, engine and airframe manuals should be regarded as the minimum inspection requirement.

It is the responsibility of L.A.M.E.'s to ensure that inspections made after propeller ground strikes are as thorough as necessary before aircraft are returned to service.



convair flies into ground during night approach

(Summary of Accident Report Released by National Transportation Safety Board, U.S.A.)

At Greater Cincinnati Airport, Kentucky, U.S.A., a Convair 880 was approaching for a night landing in the course of a scheduled passenger flight from Los Angeles, California, to Boston, Massachusetts. The flight had been cleared for an ILS approach to Runway 18 and, after reporting over the outer marker, was cleared to land. Less than a minute later, while on final approach, the aircraft struck a tree some 9,350 feet short of the runway threshold. After colliding with several more trees, the aircraft impacted heavily with the ground and was destroyed by fire. All but 12 of the 82 persons on board, including the flight crew, were killed.

The weather at the time of the accident was overcast with cloud base of a little over 4,000 feet and a surface visibility of one and a half miles in light snow. The temperature was 1° Centigrade (34°F) and the wind was blowing from 110 degrees at seven knots. The point at which the wreckage finally came to rest was 6,878 feet short of the runway and 442 feet to the right of its extended centre line. The aircraft had made initial impact with a tree at a height of 875 feet above mean sea level, or 15 feet below the elevation of the airport. At the time, the aircraft was in a straight and level attitude and on the runway heading. There was no evidence of any pre-impact failure of the airframe, engines or flight controls, nor of any in-flight fire. The undercarriage was down and locked, the flaps were extended to the 50 degree position and both spoilers and the landing lamps were retracted. The aircraft was equipped with a flight data recorder and a cockpit voice recorder and both these units were recovered from the wreckage in good condition.

At the time of the accident, Greater Cincinnati Airport's Runway 18 was 8,600 feet long and was equipped with high intensity runway lights. The approach aids normally available for this runway consist of an ILS localiser and glide slope, outer and middle marker beacons, and high intensity approach lighting, but because of construction work on an extension to the approach end of the runway, the ILS glide slope transmitter, the middle marker beacon and the high intensity approach lights were inoperative.

The ILS approach for Runway 18 prescribed an initial approach at 2,000 feet AMSL, intercepting the glide slope at the outer marker, four nautical miles from the approach end of the runway, at 1,973 feet. The inbound heading from the outer marker was 180°. The standard minima for an ILS approach in a four-engine commercial jet aircraft, with all ground and aircraft systems operational, were a 300 foot ceiling and a visibility of three quarters of a mile. With the glide slope, approach lights, and middle marker inoperative, as was the case in this approach, the minima were 400 feet and one mile. In a situation where no glide slope was available, the operator's flight procedures advised pilots to arrive over the outer marker with the undercarriage down, and flaps set at 40°, a minimum airspeed of "reference plus 10" and to start the final checklist at that point. The descent was then initiated to the minimum altitude or the final approach "slot". The rate of descent in this type of approach could be higher than normal at the pilot's discretion and the final approach "slot" was defined as that point in the approach where the pilot determined that he could safely accomplish his approach and landing.

After leaving the outer marker therefore, the aircraft should have either descended to the minimum altitude, 1,290 feet AMSL, or the approach "slot". If the runway was not in sight at the minimum altitude, the aircraft should have been levelled off and flown the rest of the calculated time towards the end of the runway. If the runway was not seen, a missed approach should have been made in accordance with the published procedure. However if the pilot determined during the descent that he was in the "slot", he should have extended 50° of flaps and continued to a landing.

Because of the circumstances of this accident, a considerable amount of time and effort was expended in an attempt to find some evidence that would indicate a malfunction of the aircraft's pitot static system. No evidence was found to support any such theory however, and there was nothing to indicate that the flight instruments were not accurately reflecting the aircraft's operation.

The evidence of the investigation, including that obtained from the flight data and cockpit voice recorders, indicated that the Convair's flight was entirely normal until some time during the descent into Cincinnatti. The descent from cruising altitude was delayed because of conflicting traffic and was begun closer than normal to the destination. Although this should not have caused the crew any problem nor affected the safety of the flight, it did require them to conduct the descent at a higher than normal rate towards the initial approach fix. The cockpit voice record showed that the crew discussed the techniques they were using to increase the rate of descent and indicated that they were relaxed and operating the aircraft within its established limits. This was confirmed by the flight data recorder.

The cockpit voice recorder indicated that the crew set and cross-checked the Cincinnatti altimeter setting on their altimeters. Shortly after the flight was transferred to the Cincinnatti Approach Controller, the crew checked the anti-icing equipment and their subsequent conversation indicated that they were not aware of any faults in the system. Throughout this part of the descent, the first officer called out the appropriate warnings to the captain as the aircraft approached assigned altitudes and apparently performed all of his assigned duties without prompting by the captain.

Weather conditions in the Cincinnatti area were such that the crew should have established visual contact with the ground by the time they reached 3,000 to 4,000 feet during the descent. As the flight approached the final fix, approximately seven minutes before the accident, the crew were given the latest reported weather which indicated that the ceiling in the vicinity of the airport was approximately 1,000 feet and the visibility was 1½ miles in snow and haze. Approximately one minute later they were reminded that the ILS glide slope was out of service, as was the middle marker beacon and the approach lights. The crew acknowledged this information and the cockpit voice recorder indicated that they planned their approach to the proper minimum altitude, 400 feet above ground level, to allow for these unserviceabilities.

From this point on the approach until passing over the outer marker, the flight data recorder showed that the aircraft altitudes and headings were in general agreement with the crew's announced altitudes, and the headings they were instructed to fly. The cockpit voice recorder also indicated that the aircraft was being operated normally during this portion of the flight, and that the proper configuration was established for the approach to the outer marker in accordance with the company's operating instructions. When the crew reported over the outer marker, they were cleared to land on Runway 18 and advised that the wind was blowing from 090° at 8 knots and the runway visibility was more than 6,000 feet.

When it reached the outer marker, the aircraft with undercarriage down and flaps set to 40 degrees was at 2,340 feet (1,450 feet above the airport elevation) flying at a speed of 200 knots. The first officer then advised the captain they had passed the marker and that there was no glide slope. The cockpit conversation recorded indicates that at this stage the captain might not have had the applicable minimum altitude of 1,290 feet AMSL fixed clearly in his mind for, in acknowledging the first officer's remarks, he began some mental arithmetic aloud to determine the minimum altitude indication. Before he completed the calculation, the first officer supplied the answer as "twelve ninety", which the captain repeated aloud. A descent was then established at 1,800 feet per minute and at an airspeed of 190 knots. Although these rates are above those recommended by the operator for instrument approaches, an examination of earlier flight records showed that the captain had previously exceeded the recommended figures when operating in visual conditions.

The rate of descent was maintained and, some 25 seconds before the initial tree impact, the flight engineer asked if the final check list was wanted and the first officer replied in the affirmative. According to the operator's procedures, the call for the final checklist should be made by the captain to acknowledge that the undercarriage is down and locked. The flight engineer's question was apparently a reminder for the checklist in the absence of a call from the captain.

Almost simultaneously with the first officer's response, and about 20 seconds before the first recorded sound of impact, the captain requested 50 degrees of flap, the selection that is normally made as the aircraft intercepts the final approach "slot". Power was reduced at the same time and the rate of descent first increased to 3,000 feet per minute, then decreased to 1,800 feet per minute. Shortly afterwards, an unidentified member of the crew remarked "Nothing to it!" and the final item on the check list was called. The aircraft was then at an altitude of 1,275 feet, approximately two and a half miles from the end of the runway. At this point in the approach the aircraft, although about 400 feet above the elevation of the airport, would have been 800 feet above the Ohio River Valley that it was then crossing. Shortly before the impact with the first tree, the aircraft was rotated into a level attitude, and the rate of descent was decreasing. The airspeed was 191 knots and the indicated altitude was 900 feet. The initial impact with the tree occurred three seconds later, and the captain exclaimed: "What's that—say, what you say, twelve ninety?"

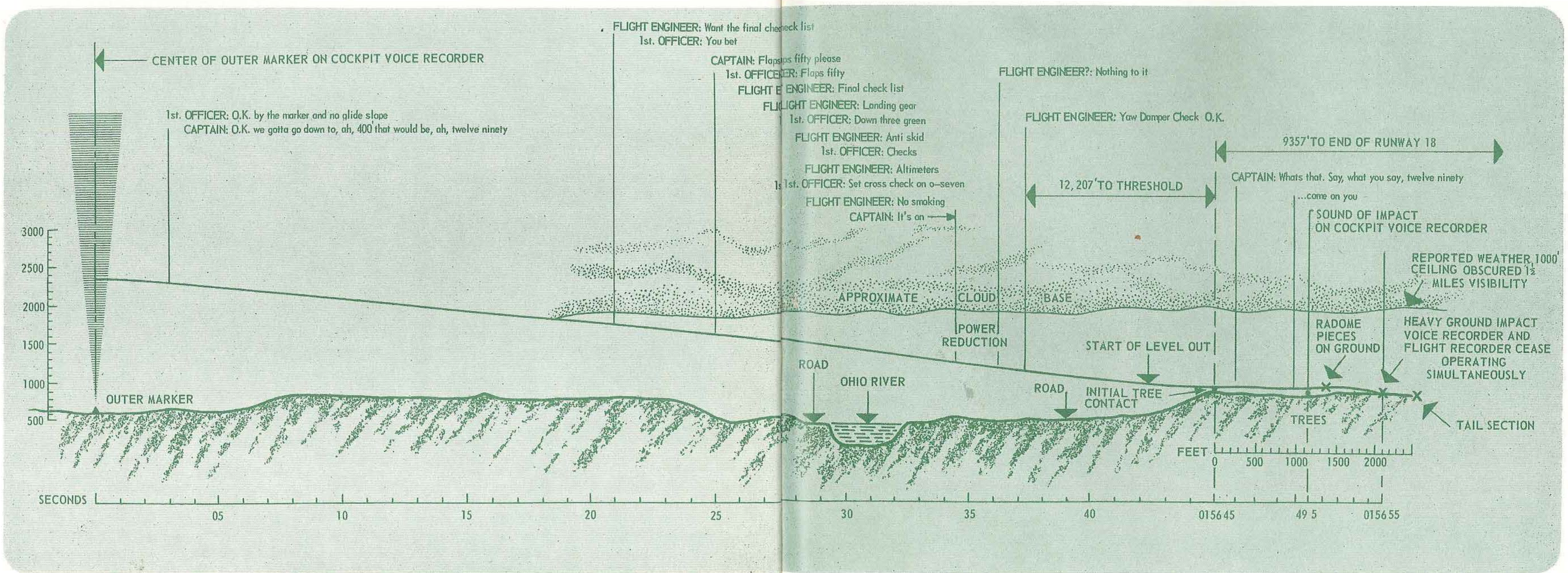
The captain then initiated a pullup with the exclamation "Come on, you!" Destructive impact occurred about half a second later.

* * *

Throughout the approach the crew conversation reflected a relaxed atmosphere in the cockpit until the last few seconds prior to impact. The crew had flown together enough to have established a rapport between the pilots and the uneventful flight and reported weather well above minima may have paved the way for complacency. Each of the pilots knew the other could do his job without being monitored and each probably felt he could count on that performance.

The activities of the flight crew as reflected in their recorded conversation indicated that, during the greater part of the time between the outer marker and the crash, the first officer and the flight

Diagram showing sequence of events during final approach as reconstructed from Cockpit Voice Recorder.



engineer were involved in accomplishing the final landing checklist. The captain's request for 50 degrees of flap and the recorded sounds of the engines changing power were the only indications there were of the captain's activities during this period. It appears that the captain knew he was high at the time of the arrival over the outer marker, and in line with the company practice of getting down to the designated minimum altitude as soon as possible during a no-glide-slope ILS approach, he initiated a rate of descent higher than that required for a normal ILS approach.

According to the flight data recorder, the airspeed, rate of descent and indicated altitudes during the final approach were such as to warrant warning calls by the first officer, but none were recorded. In accordance with the operator's procedures for this part of an ILS approach, the first officer should have called "airspeed" when the indicated airspeed was more than 5 knots different from the target airspeed, called "sink rate" if the rate of descent exceeded 1,000 feet per minute, and called when 500 feet above airport elevation and reported no warning flags on the instruments. He should then have called out each 100 feet of altitude change below 500 feet above field elevation until reaching the minimum altitude (1,290 feet AMSL), and called "runway in sight" or "minimums —no runway", as appropriate when the aircraft reached the prescribed minimum altitude. However if the first officer believed that the aircraft was in visual conditions and the captain was using visual ground reference to make the approach, none of these calls would necessarily be made. It is thus believed that the main reason that the co-pilot made no calls during this part of the approach was that he felt the captain was making a satisfactory visual approach. The possibility exists, however, that the captain's attention was divided between attempting to locate the runway ahead of him, and flying the aircraft by partial reference to ground lights or other objects outside the aircraft. Had the captain been referring to his altimeters during the start of level off, just before impact he certainly would not have been asking for a minimum altitude verification 3 or 4 seconds later in the apparently rhetorical manner in which he did. The Board believes that he was surprised to see his altimeter displaying an altitude far below his target of 1,290 feet. During this part of the flight the weather on the approach path would probably have been such as to enable the captain to establish visual reference to street and house lights in the river valley, and possibly the glow of lights in the direction of the airport. The "nothing to it" comment recorded nine seconds before impact, might have been prompted by the sighting of these lights.

It was noted during the investigation, that the profile of this particular terrain along the approach path from the outer marker to the airport may have provided the crew with an illusion of having adequate terrain clearance on their approach. The Ohio River Valley is approximately 400 feet lower than the airport mesa terrain and is separated from higher ground by a steeply rising unlighted hillside.

The Board, in studying this terrain, believes there are two methods whereby an illusionary effect might be induced. At night, under lowering visibility conditions, it is possible that the lights in the river valley could be associated with airport terrain elevation and, if used for altitude reference, would provide an illusion of adequate altitude for terrain clearance. It is also possible, since there are no lights on the steeply sloping valley side which would provide terrain definition, that the lights in the valley, associated with the lights on the airport terrain, would provide a condition of a lighted up-slope terrain illusion as described in Boeing studies on Night Visual Approaches to Lighted Sloping Terrain. In these studies, it was demonstrated that pilots making approaches to airports, in or adjacent to a lighted upsloping city, received visual cues that produced sensations of being much higher than their actual altitudes.

The Board believes the pilot used the lights in the river valley (400 feet below the airport elevation) as a visual reference to establish his final approach altitude. In this connection, the Board noted that there have been two previous accidents within 1,000 feet of the point where the Convair made initial contact with the trees. In both cases the aircraft were operating at night in conditions of limited visibility and in each case the investigations indicated that the crew saw or believed they saw, the runway lights shortly before they crashed into terrain lower than the airport elevation. In this latest case, the Convair had levelled off at about 875 feet AMSL, 15 feet below the airport elevation, but 400 feet above the river valley.

Probable Cause

The Board determined that the probable cause of this accident was an attempt by the crew to conduct a night, visual, no-glide-slope approach during deteriorating weather conditions without adequate altimeter cross-reference. The approach was conducted using visual reference to partially lighted irregular terrain which may have been conducive to producing an illusionary sense of adequate terrain clearance.