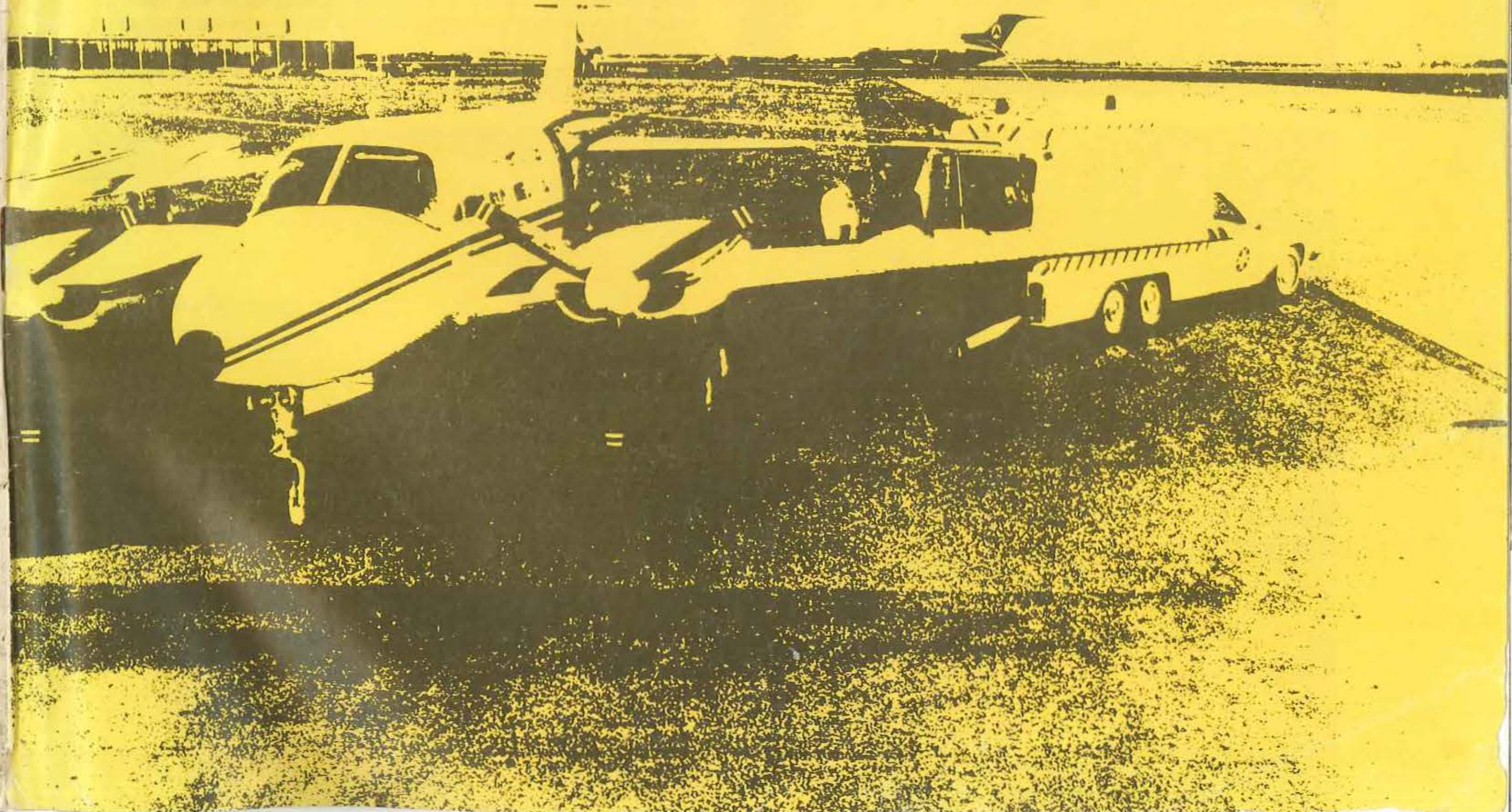
Department of Transport - Australia

102/1978

Aviation Safety Digest



FRONT COVER

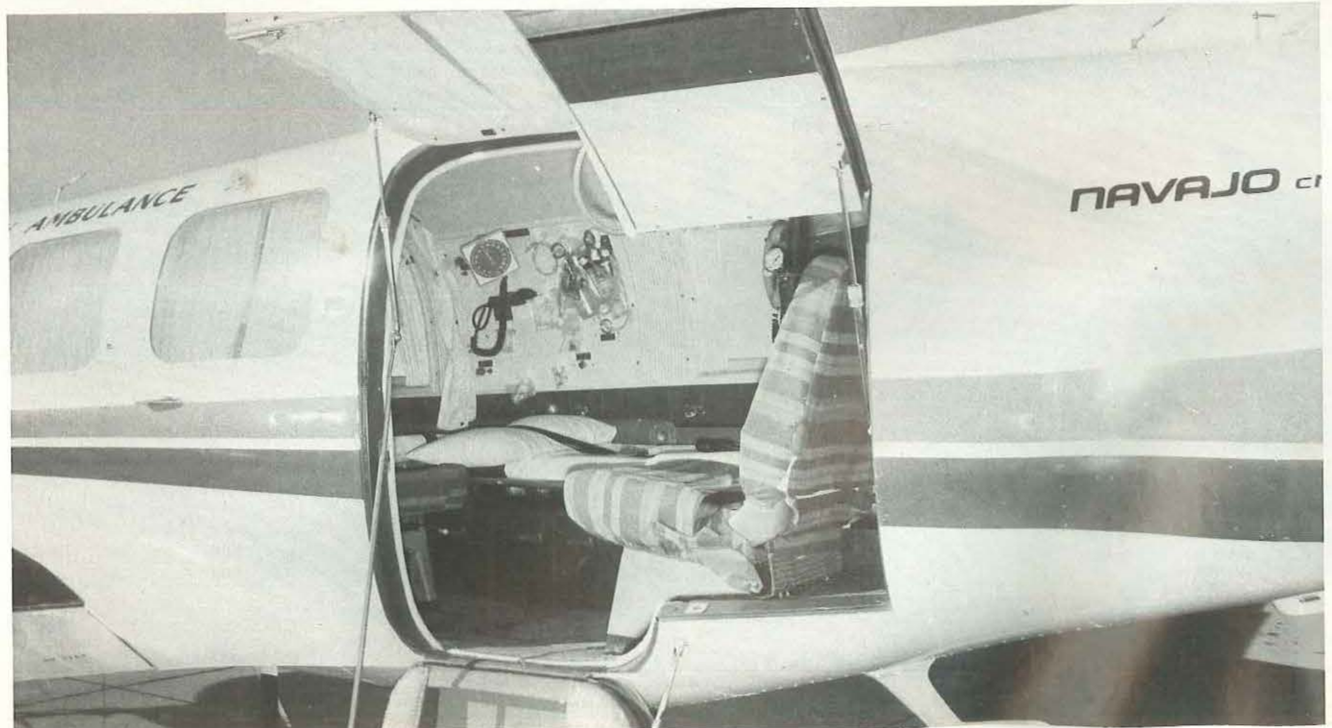
In 1961 the Whyalla Ambulance Committee was formed in affiliation with the St. John Council for South Australia to operate two road ambulances serving the Whyalla area. The service expanded rapidly and eventually eleven branch services were operating around the Eyre peninsula. In 1970 the Service was reconstituted and became the St. John Ambulance Service — Upper Eyre Peninsula Incorporated. The combined resources of the twelve offices currently support the operation of three aerial and 16 road ambulances.

The operation of the Air Ambulance began in 1965 when concern was expressed over the effects the long journeys in road ambulances were having on seriously ill patients. In October of that year a four seat Piper Cherokee aircraft was purchased and converted to an aerial ambulance. During the following 12 years of operation, the service purchased a fleet of twin engined aircraft. In 1976 this comprised three Piper Senecas and a Piper Navajo. One Seneca and the Navajo were disposed of to allow the purchase of a Navajo Chieftain, a longer version of the Navajo with more internal space. The service considers the Chieftain to be the optimum unit for aerial ambulance transport with a capacity for three stretchers, two sitting patients and an attendant — a vast improvement on the original Cherokee!

Since 1965 the St. John Air Ambulance for South Australia has carried more than 7000 patients and flown 3.7 million kilometres. The year 1976 saw a dramatic increase in operations with 1154 patients being transported, 46 per cent more than in 1975.

From its humble beginning in 1965 when the Air Ambulance only served the Eyre peninsula, the fleet now operates over the length and breadth of South Australia. Doctors in the country areas are becoming more aware of the benefits of the Air Ambulance service. The ability it provides to transport a patient from an outback centre to a major city hospital in less than two hours is an obvious advantage over the journey by road lasting up to eight hours.

The accompanying photographs show the modern equipment used by the service as fitted to the Navajo Chieftain.



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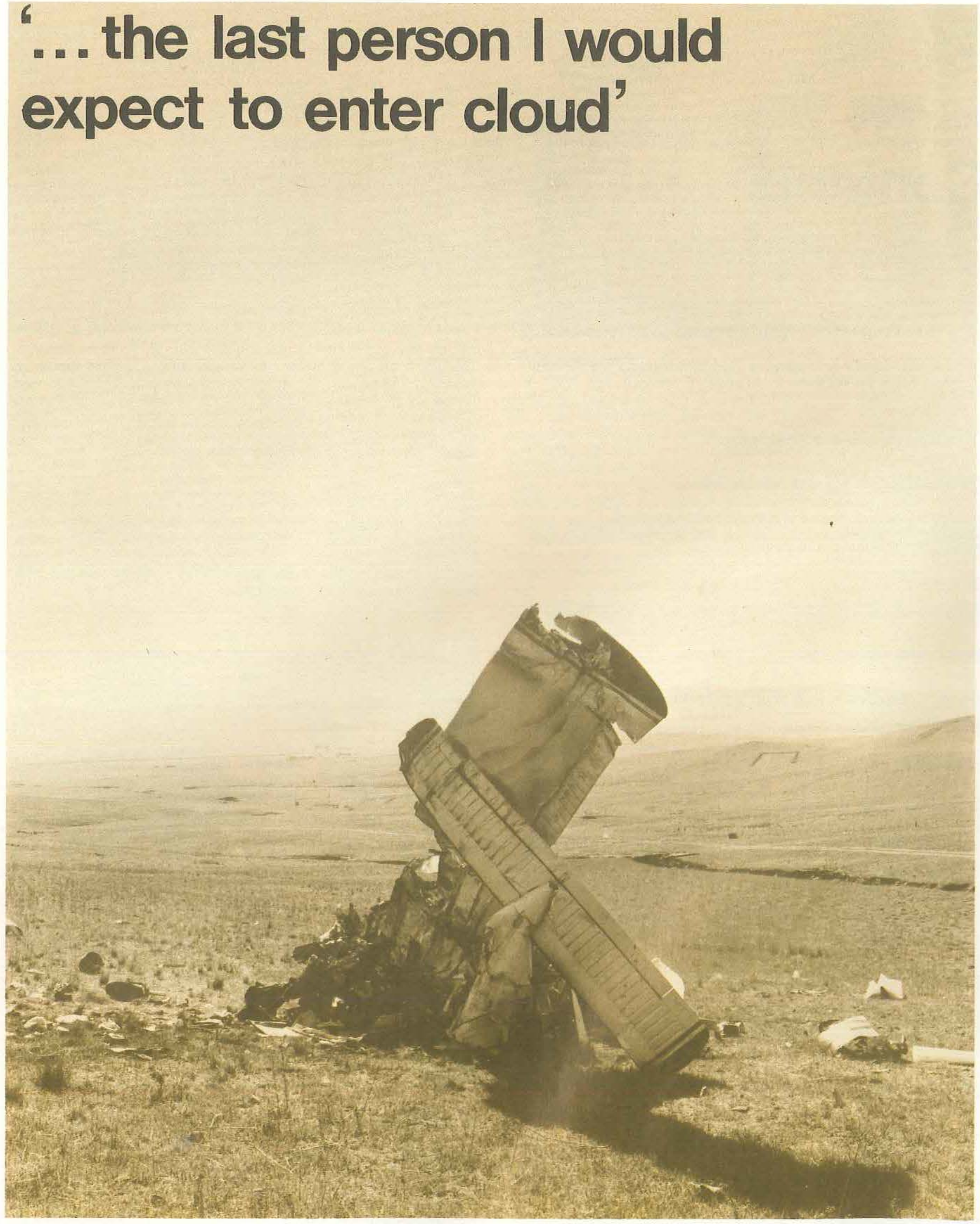
Note: Metric units are used except for airspeed and wind speed which are given in knots; and for elevation, height and altitude where measurements are given in feet.

BACK COVER

An alternative means of conveying patients by air is the helicopter. When landing space is limited and time is critical the helicopter is the most expedient means of transport. Shown here is Victoria's ANGEL OF MERCY helicopter, a Bell 206, arriving at the Alfred Hospital in Melbourne.

— with acknowledgement to the Herald and Weekly Times.

'... the last person I would expect to enter cloud'



"The whole area was covered with fog or mist. The tops of the hills to the east were completely covered with fog and it was misty underneath that, right back to the homestead. However the windmill up the track could be seen clearly. The visibility deteriorated as I climbed up the hill. I then looked down and identified a 'shape' below me. It was the crashed aircraft".

In these words a station overseer in the Mount Lofty Ranges north of Adelaide described the finding of a wrecked PA28-180 Cherokee in which a young man, his wife and both his parents were killed. It was the tragic finale to a meticulously planned flight by a very conscientious but inexperienced pilot.

The pilot was 33 years old, a serious person passionately fond of flying. As soon as the area restriction was lifted on his private licence, he began planning his first long distance flight — a return trip from Strathalbyn, 50 kilometres south-east of Adelaide, to Ayers Rock with intermediate landings at Leigh Creek and Oodnadatta. The first leg of the flight to Leigh Creek was planned outside controlled airspace at 3500 feet to Mount Pleasant, thence via Eudunda, Burra, Peterborough and Hawker at 5000 feet.

The pilot realized that with such limited flying experience he was embarking on quite an ambitious undertaking but with thorough planning and preparation he was confident that the trip would be a success. He even took his parents for a local flight to ensure that they were happy to travel with him in a light aircraft, and five days before the trip flew to Parafield to discuss the proposed flight with the briefing officer. He pre-computed the flight time intervals up to Ayers Rock and sought the advice of pilot friends on navigational procedures. These people later recalled that the pilot was particularly conscious of the folly of attempting to fly in cloud without an instrument rating. He had indicated that if he ever encountered cloud he would always turn back.

At about 0530 hours on the morning of the flight the pilot telephoned Parafield and obtained the relevant area meteorological forecasts. The forecast for the route segment over the ranges indicated a south-east airflow with scattered stratus cloud, base 1200 feet, scattered cumulus cloud base 2500 feet, broken strato-cumulus base 3500 feet and visibility of 35 kilometres reducing to 10 kilometres in showers and drizzle. The route planned by the pilot to remain OCTA took the aircraft along and almost directly above the top of the North Mount Lofty Ranges which contain numerous peaks rising to as much as 3000 feet. Cloud base heights indicated in area forecasts are expressed in feet above mean sea level (AMSL) and it should have been obvious to the pilot that there was a strong possibility these ranges would be in cloud.

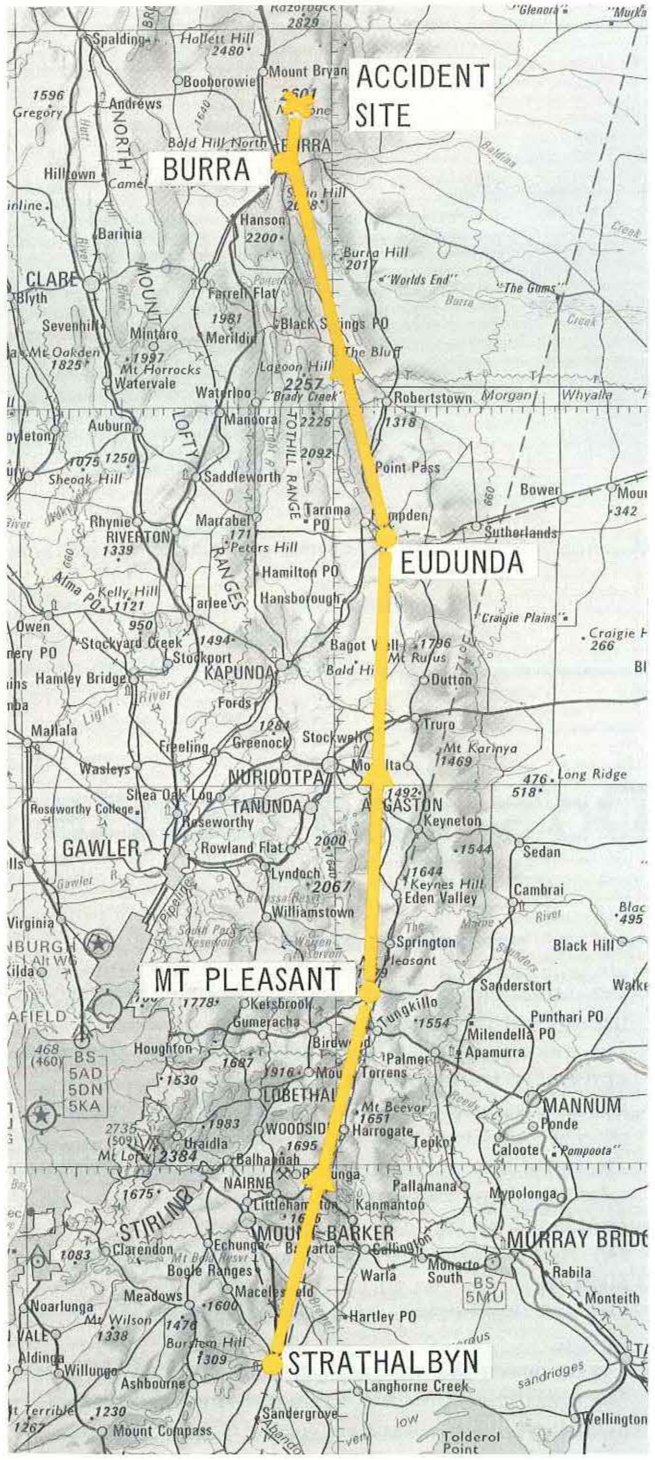
In his first radio communication with Adelaide FSU, the pilot reported that he had departed Strathalbyn at 0712 hours and was climbing to 3500 feet. At 0728 hours he reported position at Mount Pleasant and that he was descending to 3000 feet to 'remain VMC'. Three minutes later he reported descending to 2500 feet. The pilot next reported his position at 0745 hours over Eudunda but this time he made no reference to altitude. The last transmission received from the aircraft was at 0746 hours when the pilot acknowledged an instruction to change frequency at Burra Creek. It is significant that in-flight log entries later revealed that he had misidentified Burra as Peterborough.

At about 0800 hours residents of Burra (elevation approximately 1540 feet) saw a light aircraft approach from the south and make a 360 degree turn to the left. The aircraft was at an estimated height of about 300 feet and was below overcast low cloud. It flew away on a northerly heading towards the hilly terrain surrounding Mount Cone (elevation 2601 feet) some 10 kilometres to the north. Several minutes later a person in the Mount Cone area, where the hills were enshrouded in fog, heard the high-pitched sound of an aircraft engine. He caught a fleeting glimpse of an aircraft emerging from cloud at high speed before it disappeared behind a hill to the west of the mountain. This was followed by a sound of impact.

The aircraft had struck the northern slope of a hill at an elevation of 2225 feet. At the time of the crash it was in a steep nose-down attitude at high speed, and on a northerly heading. The Cherokee had virtually disintegrated and all four occupants had been killed on impact. The wreckage was examined in detail but nothing was found to indicate that the aircraft was incapable of normal operation immediately prior to the accident.

* * *

Map showing probable flight path and site of accident.



The tragedy of this accident is that the pilot could hardly have had a more correct approach, either to aviation safety or to his preparation for this particular flight. Nevertheless, although the forecast did not preclude operations in VMC, he would have been wise to have planned to avoid the higher ridges and this could have been achieved by heading west from Strathalbyn and then north along the coast through the Adelaide Control Zone.

In the cold light of the investigation, it is evident that the pilot's second error was that of persevering on his chosen track in the face of deteriorating visual conditions. On the stretch between Mount Pleasant and Eudunda it should have been apparent to him that VMC could not be maintained if the flight were continued north towards the higher ranges. This was when a diversion should have been made. However there can be little doubt that by this stage the situation had become too much for the pilot to handle at his level of experience.

Perhaps more than anything the pilot fell into the psychological trap of believing that all his exhaustive pre-flight planning would eliminate the need for last-minute in-flight revision and free him to concentrate on navigation during the flight. In his anxiety to methodically prepare for every aspect of the trip he might have overlooked the necessity for continuing vigilance and flexibility. It is surely an error to which we are all prone.

View from position of witnesses showing (A) hill behind which aircraft crashed and (B) Mount Cone.

Do's and don'ts of airmanship

(Adapted from COPA Bulletin, Canada)

- **Do shut down your engine before loading or unloading passengers.**
- **Do warn people to keep away from the propeller and not to touch it for any reason.**
- **Do taxi at a speed from which you can come to a stop at any time.**
- **Do have someone on each wing tip for guidance when taxi-ing in confined spaces.**
- **Do taxi at night only on lighted taxi ways.**
- **Do leave the controls locked after parking the aircraft.**
- **Do set the brakes or chock the aircraft on the apron.**
- **Do tie down the aircraft when parking overnight.**
- **Do use the radio only for what it was intended — and keep the channels open for important or emergency messages.**
- **Don't start your engine before being assured your propeller is clear.**
- **Don't start your engine with the aircraft's tail towards other aircraft.**
- **Don't start the engine while people are standing in front or behind your aircraft.**
- **Don't use high power while taxi-ing in close proximity to parked aircraft.**
- **Don't conduct a long pre-flight run-up in the vicinity of offices or occupied buildings.**
- **Don't ask for weather information right after take-off if you can check it by telephone before departure.**
- **Don't file a flight plan by radio right after take-off if you can do it by telephone before departure.**
- **Don't taxi on to an apron at a fast rate. Your brakes could fail.**

DME distance – from where?

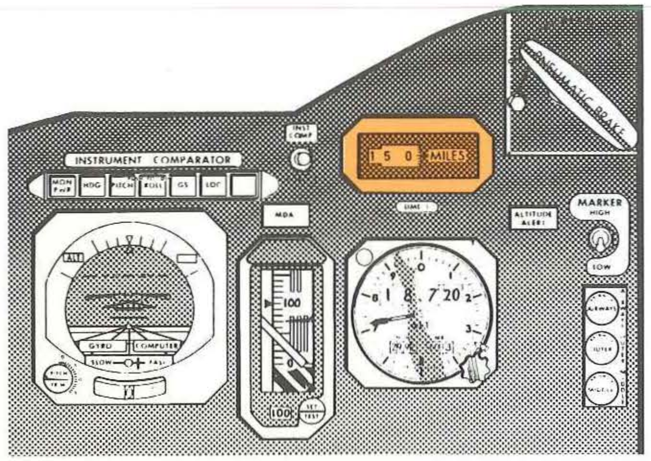
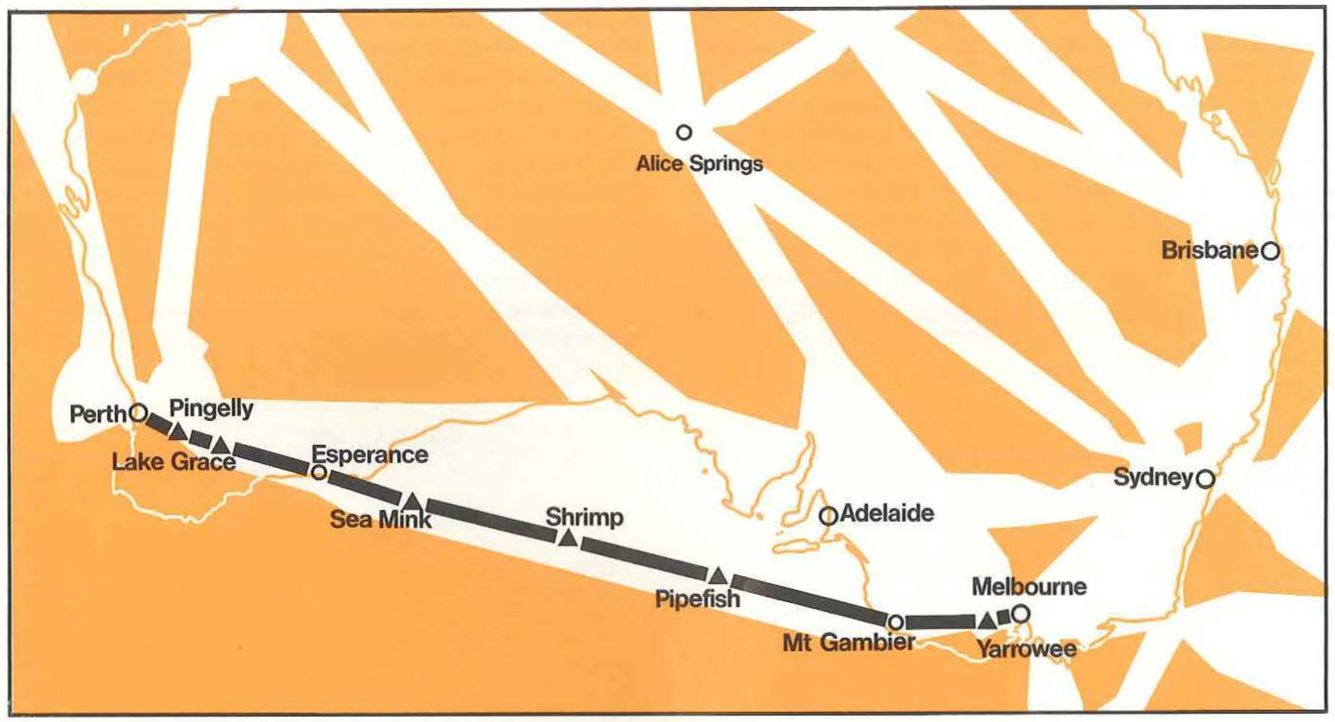


Fig. 1: Map showing air route Green 94 and designated reporting points between Melbourne and Perth.



In preparation for a scheduled flight from Melbourne to Perth, the crew of a Boeing 727 submitted a flight plan indicating that the aircraft would operate on air route Green 94, overflying Mount Gambier, the Great Australian Bight, Esperance and Pingelly. On this route, aircraft do not overfly any radio navigation aids between Mount Gambier and Esperance, a distance of 958 nautical miles, though they are within range of off-track aids at various times. While crossing the Bight on this route, position reports are required at the designated reporting points Pipefish, Shrimp and Sea Mink (See fig. 1)

Departing Melbourne at 0957 hours GMT, the aircraft climbed to flight level 330 as planned. A position report was given at Mount Gambier two minutes ahead of the flight plan estimate, at Pipefish five minutes ahead of plan and at Shrimp seven minutes ahead. The next position report was at Sea Mink at 1204 hours, eight minutes ahead of plan, and an ETA for Lake Grace was given as 1244 hours, 12 minutes ahead. At about midway between Sea Mink and Lake Grace, which is 150 nautical miles from Perth and 86 nautical miles from Pingelly, the aircraft overflew Esperance. Though not a reporting point for the flight, Esperance is equipped with VOR, NDB and DME. So far throughout the flight the first officer had logged the time of passing over all navigation aids and reporting points. At the time the aircraft passed over Esperance however, the three members of the flight crew were engaged in conversation not relating to the operation of the aircraft, and the first officer made no navigation log entry. The next navigation aids on track were the NDB and DME at Pingelly, 67 miles south-east of Perth. After passing over Esperance therefore, the captain's DME was selected to channel five, Pingelly, and some time later the first officer's DME was also selected to this channel.

At 1240 hours the crew reported that the aircraft was at Lake Grace and Perth Arrivals Control issued the instruction 'when ready, descend to six thousand, not below DME steps'. The crew had planned to commence descent 130 miles from Perth and, at 1242 hours, when the DME read 130, the captain commenced descent and the first officer reported 'left flight level 330'.

As the descent progressed however, the crew found that they were unable to read the ATIS broadcast on the Perth VOR. They advised Arrivals Control of this and were given the current terminal information. At 1256 hours they endeavoured to establish two-way communications with Perth Tower and, though the aircraft's transmissions were read by the tower controller, the crew could not hear the tower. Satisfactory communication was re-established with Arrivals Control and at 1258 hours the crew reported 20 miles from Perth. The crew made further attempts to establish communication with Perth Tower but two-way communication was satisfactory only with Arrivals Control.

At 1259 hours the aircraft was instructed to continue its descent to 5000 feet and the crew went on with their attempts to establish communication with the tower by listening to tower transmissions on the NDB frequency. This was only partly successful and communication was therefore resumed with Arrivals Control. At 1302 hours the crew reported 'coming up to six DME at 5000' and were instructed to enter the Parkerville holding pattern (based on a locator beacon nine miles north-east of Perth Airport), and to descend to 2500 feet.

At the time of the incident, the primary means of air traffic control in Perth controlled airspace was by the application of procedural control techniques. An ATC-manned radar unit was available but at that time was being used only on request to assist in resolving specific traffic separation situations, and not as the primary means of control. At 1302 hours, the Perth approach controller, appreciating that the aircraft was apparently experiencing radio navigation and communication difficulties, alerted Perth Radar and requested that the aircraft be radar-monitored. At about the same time Arrivals Control cleared the aircraft to commence a locator-omni approach but the crew replied that they were not yet ready to do so and would maintain 5000 feet. When Perth Radar advised that no radar return from the aircraft could be observed, the aircraft was instructed to maintain 3000 and, on request, the crew advised their position as 'eight DME — coming up to Parkerville'.

At 1304 hours the crew reported a failure in the aircraft's ILS equipment and shortly afterwards, in response to a query by Arrivals Control, advised that the VOR receiver was also not operating. At 1306 hours the crew were requested to establish communications with Perth Radar. After they had done so satisfactorily, the aircraft was identified by radar 50 miles from Perth approaching from the south-east. At about this same time, the crew realised that the aircraft's DME was selected to Pingelly and not to Perth. The lowest safe altitude in the area where the aircraft was identified is 2800 feet and the base of controlled airspace is 6000 feet. The crew then accepted a clearance to climb to 6000 feet, during which the radio navigation aids in the aircraft returned to normal operation. With radar monitoring, the aircraft then made a normal approach to Perth, where it landed at 1325 hours.

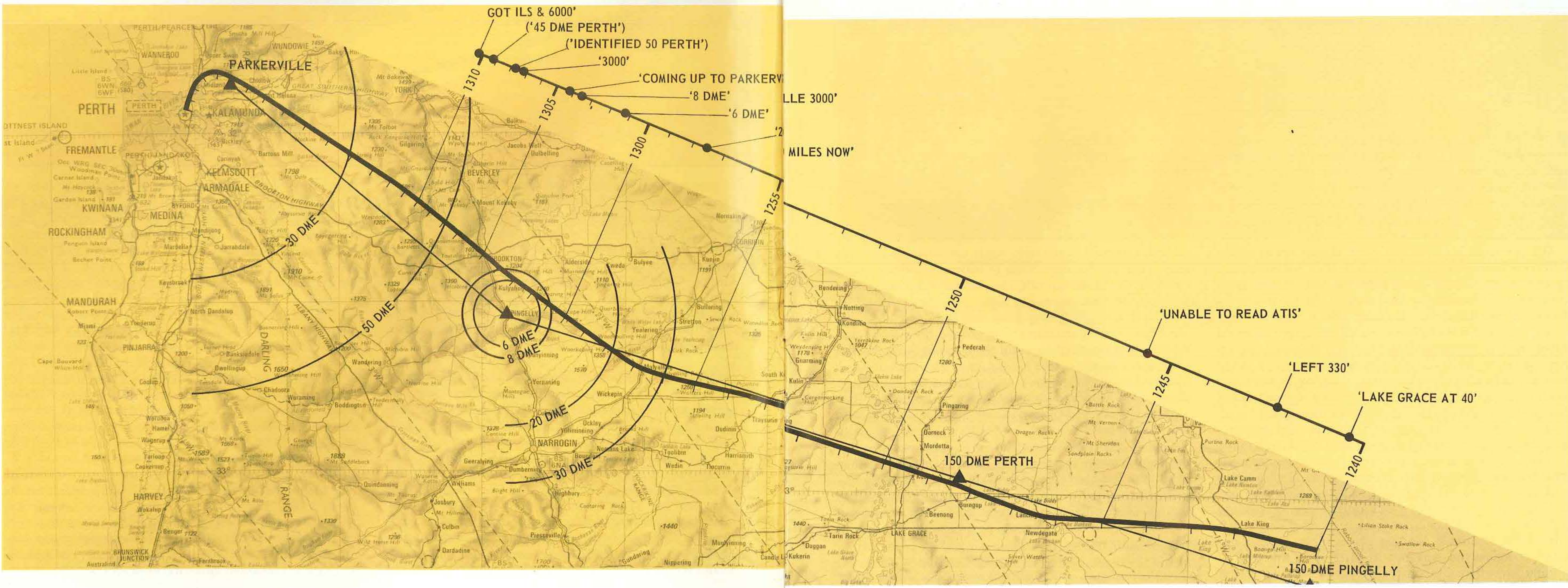
The radio antennae for Perth Tower, as well as for the Perth VOR and ILS, are located at Perth Airport. The communications antennae for Perth Arrivals Control however, are sited in an elevated position remote from the airport. For aircraft operating at lower levels to the east of Perth Airport, the presence of intervening high terrain somewhat restricts the range of Perth Tower and some radio aids, but for normal operations this does not impose limitations. In this case it is obvious that the aircraft involved in the incident had communication and radio navigation aid difficulties only because of its distance and direction from Perth, and its lower-than-normal altitude.

The grid point meteorological forecast covering the period of the flight predicted winds which would result in relatively light westerly components for the early stages of the flight, increasing to a westerly component of about 40 knots by Sea Mink and remaining at about this strength for the remainder of the flight. Post incident analysis indicates that a light easterly component would have been experienced during the early stages of the flight, gradually changing to a westerly, similar to that forecast, from Sea Mink onwards. The differences between the forecast and actual winds would account for the aircraft gaining time as far as Sea Mink and operating according to plan beyond that point.

The aircraft was fitted with a flight data recorder and the tape covering the last 45 minutes of the flight was read out and analysed. This indicated that the descent from flight level 330 was commenced 42 minutes before touchdown and that the descent continued to an altitude of 5000 feet, which was reached 24 minutes before touchdown. Two minutes later a further descent to 3000 feet was commenced and this altitude was maintained for four and a half minutes. Sixteen and a half minutes before touchdown the aircraft commenced a climb to 6000 feet and two minutes after reaching that altitude it began a normal descent into Perth. Reconstruction of the flight path of the aircraft indicated that at 1240 hours, when the crew reported at Lake Grace, the aircraft was 150 miles east of Pingelly and at 1259 hours, when some 30 miles east of Pingelly, it had altered heading to the right and commenced to track towards the Parkerville Locator. (See fig. 2)

While it was not possible to determine precisely the procedures used by the crew in relation to navigation and the use of radio navigation aids, it is obvious that those procedures were inadequate and led directly to the incident. It is also apparent that an ATC requirement to radar-monitor aircraft approaching Perth would have resulted in the incident being detected at a much earlier stage of its development.

Fig. 2: Reconstruction of flight path from position at which aircraft commenced descent from flight level 330.



Beware of power lines – in more ways than one!

Before commencing spreading operations on a farming property, two agricultural pilots discussed the work to be done and decided that one would treat the area east of the strip while the other worked to the west. They also discussed the possibility that if they both returned to the strip at the same time, one aircraft could land on a clear area close to the prepared strip.

The prepared strip was aligned almost north-south, with trees bordering the eastern side of its northern half. Further south on the same side, the tree line receded from the strip, leaving a clear area to the south-east of the southern threshold. Because the superphosphate dump was near the southern end of the strip, it seemed convenient for one aircraft to land into the south on the prepared strip, while the other landed northwards on the natural surface of the clear area, angling in from the south-east towards the dump. The two aircraft could then taxi up to the dump from opposite directions.

Operating from the prepared strip on the previous day, the pilot of one of the aircraft, an Airtruk, had made an angled approach to the prepared strip across the clear area but had not actually landed on it. He had also walked out on to the cleared area for a short distance, and noted that the surface was satisfactory for landing and that there was a contour bank running along the left side of the available landing area. What he did not notice, because he was not at that time thinking of landing anywhere but on the prepared strip, was that there were double power lines running across the clear area at an angle of about 30 degrees, just at the point where an aircraft landing on the clear area would be low on final approach. The supporting poles, 260 metres apart, were hidden amongst trees on either side of the clear area.

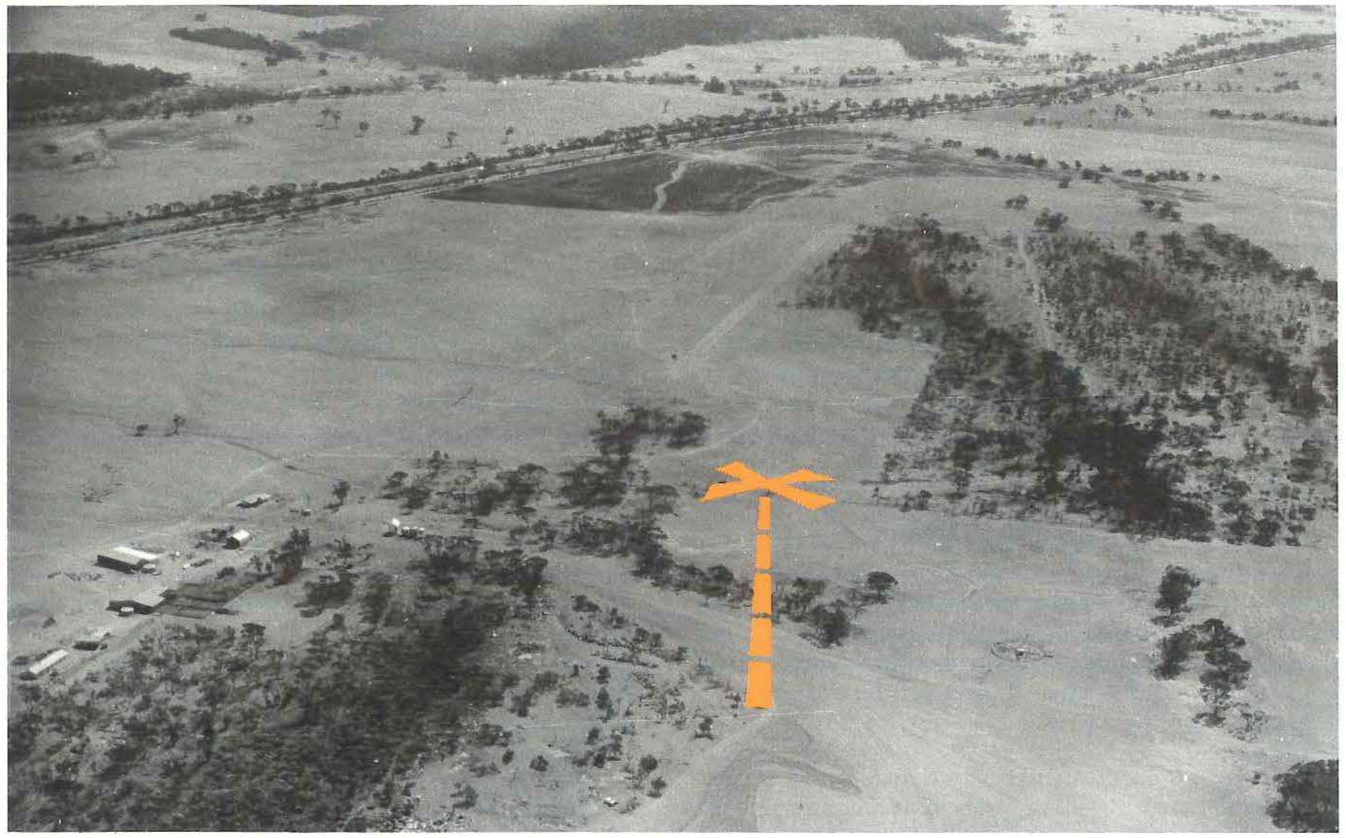
At the completion of the first spreading flight, the Airtruk returned to the strip while the other aircraft was still at the super dump. So as to leave the prepared strip clear for the other aircraft, the Airtruk pilot decided to land on the clear area and nose-in to the super dump from that side. He made a slow approach down between the trees, looking mainly at the ground because he was conscious of the need to avoid the contour bank. He did not see the power cables at any time. The next thing he knew was that the aircraft was decelerating rapidly and that one of the two tail-plane booms had broken off. The aircraft just seemed to stop in mid-air, slew around, and fall to the ground.

One of the two power cables had passed over the engine and under the port wing, cutting into the fuselage below the windscreen and breaking when it struck the windscreen pillar. This caused the aircraft to swing to the left. The other cable caught under the right hand door handle but did not break, thus bringing the aircraft down almost vertically.

The pilot was seriously injured in the impact and though conscious, was unable to move. The loader driver ran to the aircraft but found he could not reach the pilot because the door was held shut by the power cable caught under the handle. Without thinking, he grasped the cable with both hands and wrenched it away, lacerating his hands as the cable sprang back and upwards.

The loader driver's reaction was of course quite natural, but could have proved fatal. Experience over the years indicates that in most accidents in which aircraft collide with electric transmission cables, the transmission system protective relays operate as designed. But there are circumstances where the transmission cables can remain alive, in which case contact with them, or with the aircraft if the cable is still attached, could be fatal. Electricity authorities have advised the Department that all dislodged transmission cables should be treated as alive until cleared as safe by the local electricity authority.

Aerial view of agricultural strip looking in a northerly direction. The accident site and direction of approach are shown.



Programmed mind

Have you ever wondered why people disregard their own safety to get to a destination? It's primarily because we 'program' our minds, prior to take-off, to accomplish the task we set out to do. In some people this programming unfortunately overrides any admission that the flight may *not* reach its destination.

Unless you acknowledge the possibility that something could stand in your way, you aren't likely to program your alternatives — such as turning back in the face of poor weather. Similarly, a pilot who discounts the likelihood of fuel contamination is less likely to do a thorough pre-flight check.

Recently, a scheduled commercial flight failed to reach its destination although the captain thought it had! He had reached the vicinity of the destination airport when he requested a visual approach because he had the field in sight. But what he did not know was that the field was not his destination — a fact that became quickly apparent to air traffic control. As the pilot was not on the tower frequency, ATC asked the airport to blink the runway lights and give the aircraft a red light. Despite these obvious signals the captain landed the aircraft at the wrong airport.

The captain's mind was programmed to the point where it rejected interfering inputs, even though there were clear indications that something was wrong.

Quite a number of accidents contain this 'programmed-mind' problem.

– Aviation Safety Letter, Canada.

Some thoughts on aircraft accidents and their prevention

by Olof Fritsch
(Chief, Accident Investigation and Prevention Section, ICAO Air Navigation Bureau)

It was still dark when I awoke. My head was resting against the head of the bed; that was probably the reason for my headache. Meadow larks were singing nearby, so it would probably be a fine day. Strange sounds intruded — a crackling like that of cooling metal and a repeated sizzling like water drops on a hot stove.

Then it hit me. It was not a fine day — it was a very bad day. The headboard was the rough surface of a runway and I was hanging upside down in a Harvard that had flipped over on to its back during landing. The crackling sounds came from the still-hot engine; the hissing noise from fuel dripping on a hot exhaust pipe. I remembered picking up a passenger in a cow pasture by a radar station, the bouncy take-off on the rough surface, the approach at home base and my concentration on a smooth three-point landing in the old Harvard, so different from the jets I usually flew. It had been a straight, smooth touchdown, immediately followed by a quick swing to the right. No problem — ease on left rudder. Intensified swing — still no problem, a little left brake will stop it. Then the helpless feeling that the world was governed by some new, terrible laws because terrifying things were happening too fast to comprehend — the nose of the aircraft striking the runway, the propeller bending, a very loud noise. After that — nothing.

This simple accident, like all accidents, had several causes. The first was the take-off in the rough cow pasture. It bent the tailwheel and caused the swing on landing. The second cause was a rudder-brake control interference which resulted in right brake being applied when the left rudder pedal was pushed forward. Thus, left rudder didn't correct the swing — just intensified it. The final application of left brake then made the nose-over inevitable, as both brakes were on.

Knowing the causes, how could this accident have been prevented? By bigger and better tailwheels? By not using the Harvard for personnel transportation? By punishing the pilot? These are but a few choices. The preventive action taken in this case worked well — to my knowledge, there were no more accidents of this type. More about that later.

Fences or ambulances?

I tip my hat to the unknown author of the accompanying poem. It illustrates what accident prevention is — and what it is not. Do we build fences to prevent accidents, or do we buy more ambulances?

Management and human error

Before dealing with these aspects let me define the term 'management' which is here used in its general sense. Stated simply, management is getting things done through people. Taken one step further, good management gets people to do things the right way. Good management may apply equally to an aircraft manufacturing plant, to an airline or to a government department which administers aviation.

The term management is often used in industrial safety. When it comes to accident prevention, the professionals in that field appear to have some very good ideas. No wonder, they started long before aviation began! The first industrial plant safety inspections were held in the United Kingdom in 1833, and safety legislation was introduced in Germany in 1869.

Today, a consensus is emerging that 'accidents are caused by human error' and, to drive the point home and to establish a foundation for accident prevention, it continues: '... and can be traced to imperfect management related to planning, organizing and controlling.'

To managers, that may sound like an unfair over-simplification. However, it is founded on the belief that we can learn from our past experiences and that there are precious few, if any, new types of accidents. Further, the identification of risks and hazards must surely be a management responsibility.

I tried this concept on some of my colleagues. Sooner or later, we started talking about accident causes. One discussion went like this: 'How about material fatigue failures? They result from design, manufacturing or maintenance errors. Not enough material, sharp corners, tool marks not detected in quality control, etc. Surely we should know about all that by now — the bending of cast iron bars was first investigated in 1849'.

Another concerned aircraft striking the ground on approach and landing: 'This one is more complex; the specifics of each accident are different. Inevitably they relate to the man, the machine and the environment, sometimes all three together, and their relationship to each other. Some typical management questions that could be asked are:

- Was the pilot properly trained, supervised and checked on that aircraft?
- Was he properly advised about that thunderstorm on approach?
- Why did the approach chart not show that hill?
- Why was the altimeter set wrong?
- Since some mistakes are more fatal than others and

(continued on page 12)

THE AMBULANCE IN THE VALLEY

'Twas a dangerous cliff, as they freely confessed,
Though to walk near its crest was so pleasant;
But over its terrible edge there had slipped
A duke, and full many a peasant.
The people said something would have to be done,
But their projects did not at all tally.
Some said 'Put a fence 'round the edge of the cliff,'
Some, 'An ambulance down in the valley.'

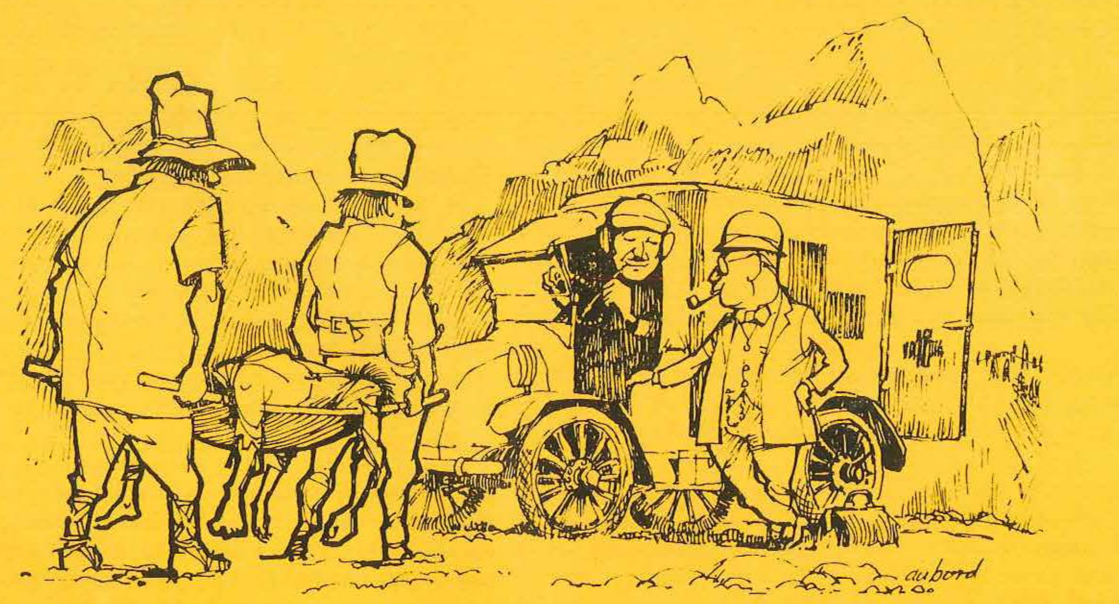
The lament of the crowd was profound and was loud,
As their tears overflowed with their pity;
But the cry for the ambulance carried the day
As it spread through the neighbouring city.
A collection was made, to accumulate aid,
And the dwellers in highway and alley
Gave dollars or cents — not to furnish a fence —
But an ambulance down in the valley.

'For the cliff is all right if you're careful,' they said;
'And, if folks ever slip and are dropping,
It isn't the slipping that hurts them so much
As the shock down below — when they're stopping.'
So for years (we have heard), as these mishaps occurred
Quick forth would the rescuers sally,
To pick up the victims who fell from the cliff,
With the ambulance down in the valley.

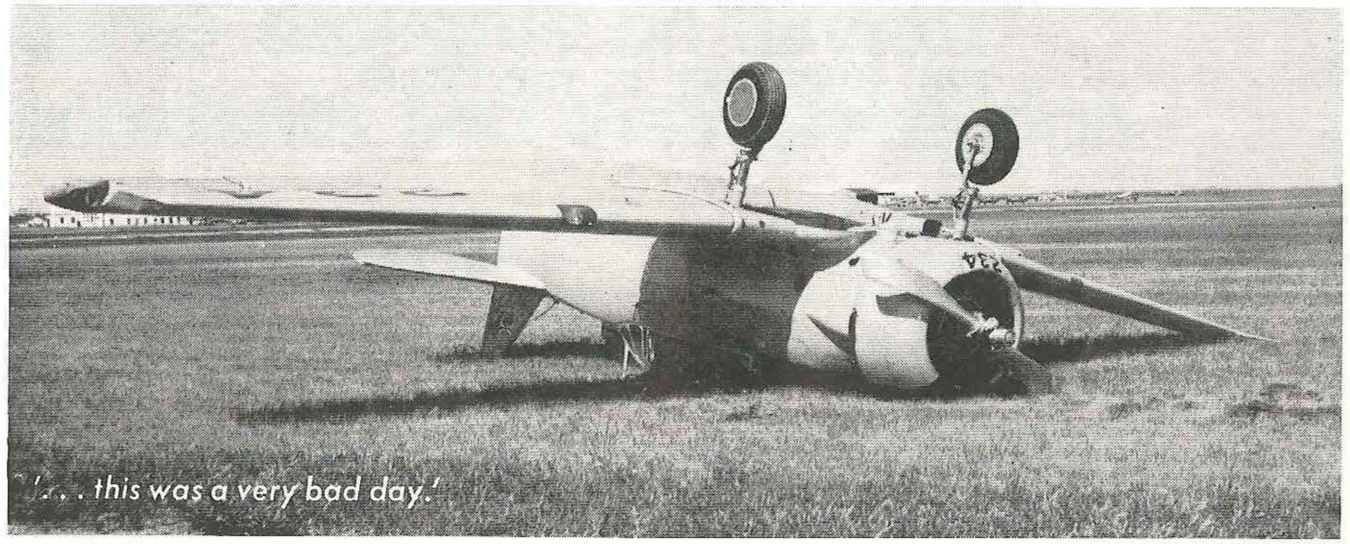
Said one, to his pleas, 'It's a marvel to me
That you'd give so much greater attention
To repairing results than to curing the cause;
You had much better aim at prevention.
For the mischief, of course, should be stopped at its source;
Come, neighbours and friends, let us rally.
It is far better sense to rely on a fence
Than an ambulance down in the valley.'

'He is wrong in his head,' the majority said;
'He would end all our earnest endeavour.
He's a man who would shirk this responsible work,
But we will support it forever.
Aren't we picking up all, just as fast as they fall,
And giving them care liberally?
A superfluous fence is of no consequence,
If the ambulance works in the valley.'

The story looks queer as we've written it here,
But things oft occur that are stranger.
More humane, we assert, than to succour the hurt
Is the plan of removing the danger.
The best possible course is to safeguard the source
By attending to things rationally.
Yes, build up the fence and let us dispense
With the ambulance down in the valley.



Cartoon: John Dubord, Ottawa, Canada


'. . . this was a very bad day.'

since humans will make mistakes, what can be done to have the machine or the system prevent these fatal errors?'

And so it went. The only accident we could conceive for which we saw no error and hence no management involvement was one in which an aircraft on landing roll went into a large hole in the runway which suddenly appeared because of an earthquake.

In industrial safety, the management concept is gaining acceptance because it seems to prevent accidents better than any other. In recent years, aviation also has been moving in this direction, but without the benefit of a clearly defined concept.

The time may now be right for the formulation of such a concept on the basis that accidents are caused by human error which can be traced to imperfect management. The first part of such a concept must be that, since management is a human activity, it is prone to error. What is needed therefore, is a system that reduces such errors to a minimum.

Aviation management

Aviation management usually comprises several organizations: the State administration, the manufacturing industry and the operators. They all have a part to play in accident prevention. They also have one thing in common — the man with the ultimate responsibility for safety and accident prevention is the man at the top, since he is in charge of the planning, organizing and controlling of the organization. Only he can authorize the programmes required to get people in his organization 'to do things the right way' so that managerial and other errors are reduced. Only he can authorize the funds required for the elimination of these errors.

Let us also face up to the fact that accident prevention costs money — in the short term. However, in the long term, it should save money since it reduces the financial losses and increases organization efficiency.

It is not only the fact that a fatal accident may incur a direct cost of half a million dollars for each fatality that should motivate good aviation management, but the reduction in errors relating to design, manufacture, maintenance and operation of aircraft should make the utilization of aircraft more efficient. That is the heart of the management concept: improvement of both safety and efficiency.

Investigation considerations

When an accident does occur, the investigation must establish and document all the circumstances and causes of the accident. Given that the causes of an accident relate to human error and imperfect management, the investigating group should be so organized that external influences, real or imagined, cannot affect the investigation.

To maintain investigation objectivity, a number of principles should apply to the investigating organizations including:

- It should report directly to the head of the government department to which it is attached, or be a statutory body in its own right.
- It should have access to sufficient funds to properly investigate accidents as they occur. The nature of the task is such that annual fixed budgets are not appropriate for this purpose.
- It should have a statutory right to investigate all accidents in its jurisdiction.
- Its expressed purpose should be the determination of accident circumstances and causes and the formulation of safety recommendations to prevent recurrences.

The effect of these principles on an investigating organization is like hanging a large sign over the entrance that declares 'here, we tell it like it is.'

Punishment counter-productive

In the past, punishment of the pilot was seen as accident prevention. Fortunately, the realization that 'the pilot is the first person to arrive at the scene of an accident' convinced management that pilots did not fly around with the intent of having accidents. Further, management began to realize that it had a responsibility in the selection, training, supervision and equipping of pilots, all factors which may cause a so-called 'pilot error.'

In fact, punishment is counter-productive to accident prevention. For example, when a pilot is punished for a near-miss that he reported himself, other pilots in that organization are not likely to voluntarily report near misses or incidents. Thus, a most reliable source of information on hazardous conditions is lost.

Similarly, if blame and punishment is meted out to the engineer who designed a square hole in a high stress area; to the administrator who failed to write proper regulations; to the manager who did not budget for the required modification of the aircraft; to the mechanic who installed the ailerons in reverse; or to the investigator who missed the fatigue crack in the wreckage, then these people will not readily accept responsibility or volunteer information.

Accordingly, accident prevention must be directed, not at individuals, but at the management system, its policies and procedures. Accidents are symptoms of something wrong in the management system.

Top managers, whether in administration, manufacturing or operations, cannot by themselves prevent all human errors or find all hazardous conditions. For that they need help and that help usually takes the form of a safety officer or organization. In some States, such safety organizations are required by legislation.

On behalf of the top manager, the safety organization usually does the following:

- Identifies and defines safety problems which have not been detected and corrected by management;
- Assesses severity of safety problems;
- Informs the responsible functions of management (engineering, operation, finance, legal, etc.) of safety problems, their urgency and, if applicable, related deadlines for preventive action;
- Measures the effectiveness of preventive action taken.

Note that while the safety organization identifies and defines the safety problem it may also suggest preventive action. However, that should only be done in general terms, with the understanding that the required expertise for detailed technical solutions must rest with management. To do otherwise would require a very large safety organization because of the expertise required in making specific, detailed recommendations. Further, it would also tend to remove from management its responsibility for accident prevention.

The safety organization is directly responsible to the top manager because he is ultimately responsible for the safety of his organization. Routine reports to him usually include problems detected and preventive action taken. Also, when agreement about safety problems and prevention cannot be reached between the safety organization and management, the final decision is referred to him.

In summary, significant improvements in aviation safety have been achieved in the last 20 years. If we wish to actively pursue further improvements, serious consideration should be given to the management approach to accident prevention. Experience in other fields of safety indicates that this may be a simple, easily understood and effective approach.

Oh yes, I almost forgot. My own misadventure did not result in punishment. Instead, the preventive action was to prohibit take-offs and landings on unprepared grass surfaces (cow pastures) — and the elimination of the control interference. Operations from prepared grass-fields continued.

Comment

The Department of Transport is interested in furthering the cause of aircraft accident prevention by every available means. The foregoing article promotes several thoughts on accident prevention for various elements of the industry, the principles behind which are supported by the Department.

Compass confusion

On a clear cloudless night the pilot of a Cessna 182 navigationally 'mislaid himself' in the course of a 55 kilometre Night VMC flight to a capital city airport.

The aircraft was equipped with normal IFR instrumentation — coupled auto-pilot, VOR, ADF, DME and a transponder. The pilot's total flying experience was 160 hours, about 20 of which were at night including 15 hours instruction. He was already rated on the ADF and had been receiving instruction on the VOR, so he decided he would practise VOR procedures on the short flight. A student pilot with only limited experience was in the co-pilot's seat.

Before take-off the pilot synchronised the directional gyro and compass. Once airborne he settled on to the desired heading of 247 degrees M, set the DG bug to that heading but was then distracted by flickering cockpit lights. He therefore asked the student pilot, who was holding a torch, to read the compass heading out to him. The heading read off by the student pilot did not agree with that on the DG, so the pilot reset the DG. He then engaged the auto-pilot and the aircraft went into a turn to take up the bug heading. The pilot then returned his attention to the cockpit lighting problem. Having fixed this to his satisfaction, he selected the destination frequency on the VOR, identified the station and checked the indications. A few minutes later at ETA over a reporting point 37 kilometres from the destination airport, the pilot saw town lights below so he reported as over that position.

The approach radar controller was unable to locate the aircraft on radar, so he queried the position report and asked the pilot if he had the city lights in sight. The pilot replied negative and indicated that he was now unsure of his position.

As the aircraft was still not painting on radar in the area it was supposed to be, the controller requested the pilot to climb to 6000 feet. After several exchanges of communications concerning heading and DME distance, the pilot was requested to 'squawk ident', whereupon the aircraft was identified about 80 kilometres from its destination, heading approximately 020 degrees. The pilot was instructed to ignore the compass and DG headings and to turn right. The controller monitored the turn and, when the aircraft was heading back towards its destination, he advised the pilot to hold that heading. Radar monitoring and vectoring was provided until the pilot reported he had the airfield in sight.

Subsequent checks found no faults in the compass, DG or VOR equipment. It appears the student pilot misread the compass to the extent that the heading he gave to the pilot was about 180 degrees in error. The pilot, distracted by other things, accepted this heading without question and thus set himself up for total confusion when he attempted to practise the use of aids on which he was not fully proficient.

Night VMC flight is based on visual navigation, supplemented by whatever aids the pilot has available and is capable of using. In this case the pilot obviously got his priorities reversed.

A simple investigation?

A recent incident report involving less than standard aircraft separation in a primary control zone provides a good example of the way that an investigation can develop — and what the incident reporting system is all about.

The incident occurred during a night departure by a DC-9 from a capital city airport. At the time there was a fairly busy sequence of both departing and arriving airline aircraft and as well several light aircraft were transitting the control zone in Night VMC.

The departure clearance given to the crew of the DC-9 before taxi-ing was a standard instrument departure (SID) which required the aircraft to climb on runway heading to 3000 feet then make a right turn through 170 degrees. However, after take-off, the aircraft was seen on radar to continue on runway heading beyond the point at which DC-9s normally turn when departing on this SID. The departures controller therefore immediately instructed the aircraft to turn right. During the turn the DC-9 came within three kilometres of a light aircraft which was overflying the area.

From the initial incident report it appeared that the main factor in the development of the incident was an inadequacy in the presentation of the SID, but after the aircraft's flight data recorder had been read out, a transcript of the air-ground communications studied, and interviews conducted with the air traffic controllers and the flight crew, it was determined there had been an overall breakdown in the entire departure system.

The full circumstances of the incident are beyond the scope of this article, but the human involvement highlights the significant effect that a minor distraction, coupled with less than normal attention to detail, can have on flying safety in a high workload situation.

* * *

The flight which the DC-9 was to carry out was entirely routine. For the crew it was a short duty spell of only two sectors and during flight planning there had been no apparent weather problems, or other foreseeable difficulties. As well there were no loading delays or unserviceabilities with the aircraft, and the pre-flight checks were routine. The aircraft was heavily loaded and for this reason the crew had planned to take-off with five degrees of flap.

While taxi-ing, the captain saw two other DC-9s (let us call them aircraft A and aircraft B) waiting at the runway intersection for departure and assumed that the second one was that of another company operating a parallel service to his flight (it was in fact the first, aircraft A). He therefore elected to cancel his planned intersection departure clearance and to use the full length of the runway — the extra taxi-ing permitting a more leisurely completion of the pre-take-off checks, and it seemed that this would take no more time than waiting for an intersection departure. This change worked out well and the captain arrived at the holding point for the runway threshold '. . . in a completely happy state . . . ', anticipating that he would be number three (aircraft C), to depart behind the two DC-9s at the intersection.

An instruction to line up before the second of the other two DC-9s (aircraft B) came as a pleasant surprise to the captain as he thought this would put him ahead of the other airline's service. The heavily-loaded aircraft and an adverse runway slope involved some minor power handling difficulties, but he made haste to get on to the runway. As the captain turned on to the runway alignment, the ATC clearance was amended to include a 4000 foot height restriction. This involved an additional cockpit workload, causing the crew to become engrossed in the task of re-setting the altitude alerting system. As a result there appears to have been no positive planning for the effects of the height restriction on the operation of the aircraft — in particular the handling of the power in regard to the need to level off at 4000 foot.

Having lined up, reconfigured the altitude alerting system, checked the cockpit instrumentation, and applied take-off power, the captain confirmed with the first officer the requirements for the standard instrument departure and that there was a 4000 foot height restriction.

The take-off was uneventful and during the initial climb it seems that the captain relaxed his concentration. This is suggested by the fact that, after the undercarriage had been retracted and the flap-slat retraction had been made at the appropriate time, he overlooked the reduction to climb power until it was mentioned by the first officer. This reminder, coming when the captain had apparently 'got behind his aircraft', certainly prompted him to reduce power, but by this time things were happening quite fast and a further extraneous factor then intervened. At this point Departures Control transmitted, 'Aircraft C, turn right heading 180 for a pilot intercept of outbound . . . correction, aircraft A, turn right 180 for a pilot intercept . . . etc'. The captain initiated a right turn but then, realising that the instruction was not for him, quickly resumed the runway heading. Nevertheless this untimely distraction provided an additional obstacle to his ' catching up ' with the situation.

Because of the initial high power settings being used and the quick clean-up of the five degree flap and slat setting, the aircraft had been climbing at 2800 feet per minute and was rapidly approaching the 3000 foot height at which the SID required a right turn. The captain was belatedly reducing power when the erroneous ATC instruction caused him to commence and then cancel a turn. But while all this was going on, the aircraft went through 3000 feet without the turn being initiated as stipulated by the SID and it seems that the captain's mental processes had probably shed this requirement as a result of being overloaded by the rapidly developing circumstances.

Within three seconds of the other DC-9 (aircraft A) acknowledging its turn-right instruction, ATC queried whether the DC9 involved in this incident (aircraft C) was also turning right. The crew associated this question with the previous exchange and answered 'Negative'. ATC then instructed the aircraft to turn right immediately. The captain responded without delay and noted that by this time the aircraft had reached an altitude of about 4000 feet.

Throughout all this, the captain was apparently most conscious of the 4000 foot height limitation, but then exceeded this altitude primarily because he had not considered the very substantial power reduction necessary to maintain level flight at a speed of 210 knots (another operational consideration) while carrying out the 180 degree turn as required by the SID. As a result, the aircraft's speed built up to about 320 knots and it reached an altitude of about 4900 feet before the captain could take positive action to reduce power and return to the assigned altitude.

During the 45 seconds in which the aircraft inadvertently climbed from 4000 to 4900 feet, ATC addressed two further messages to the aircraft concerning the terms of their departure clearance. No doubt this distraction, occurring before the crew had fully caught up with their earlier problems, was also significant. It should be appreciated however, that this was an instinctive reaction by a controller who had also been exposed to a situation of heavy workload with considerable stress.

Altogether this was a human factors-type incident for which there is no simple fix. Nevertheless, crew simulator training exercises have been revised as a result, to place additional emphasis on departures involving late changes to airways clearances. The implications of the incident have been publicised within the company concerned as well as being brought to the attention of all appropriate operators, and ATC is again critically examining terminal area procedures with particular reference to last minute changes to clearances and the imposition of altitude restrictions on SIDs.

The purpose of incident investigations is to try to find out, not only what happened, but *why* it happened. We may not always find all the facts, but in this case we believe we uncovered the areas of significance. An understanding of how a carefully devised system, operated by highly skilled and experienced professionals, can break down is surely of value to all levels of the industry.

Are you security conscious?

There are some readers who can still remember the days when motor cars were functional open affairs — with canvas hoods the only concession to creature comfort. Their controls too were simple and straightforward, with no such refinements as ignition keys and locks — instead you simply turned on the very functional ignition switch before you went about starting the engine on the crank handle. Yet there wasn't much risk of someone taking your car. For if you had one, you were numbered among the privileged few and the not-so-lucky citizenry just stood and watched with varying degrees of awe.

Time marched on and men like Henry Ford and William Morris came along who thought that cars could be much cheaper if they were mass-produced. And so it proved — and the family car became a way of life. But then alas, so did car stealing, so much so that the powers-that-be were finally forced to introduce legislation making it an offence to leave your ignition keys in your car when it was unattended. Today, to further reduce the incidence of car stealing, manufacturers are also required to fit a steering lock to their products.

The price of progress being what it is, the same situation seems to be developing with light aeroplanes. In the days when aeroplanes were a rarity, they remained unmolested — except perhaps for the occasional daring, very enthusiastic souvenir hunter. To the rest of the populace they were untouchable, exotic machines, flown by no ordinary mortals, that had little or nothing to do with everyday life. But as the light aeroplane has followed the motor car into mass production, it too has tended to be taken for granted. Regretfully as a result, aeroplane stealing has now become a fact of life.

Motor cars driven by inexperienced but exuberant and often alcoholically overloaded joy riders are of course highly dangerous. But an aeroplane in similarly irresponsible hands becomes the near-ultimate lethal weapon. And as with motor cars, inexperience and alcohol play a prominent part in accidents involving stolen aircraft. Even though some would-be pilots have actually managed to survive after becoming airborne, the aircraft itself is almost inevitably written off. And in the cases where the joy riders have failed in their attempts to take off, the aircraft has usually been quite severely damaged in one way or another. As most readers will have already guessed, a common feature in most instances of aircraft stealing is the fact that the owner or operator has unwittingly aided and abetted the theft by neglecting even the most elementary security precautions.

After one recent fatal accident involving a stolen light aeroplane, the Department conducted a survey of aircraft left parked at a busy general aviation aerodrome. Most of the aircraft examined were tied down to stop them being blown away, but almost no precautions had been taken to prevent them being flown away! Ignition keys were left in switches or in some easily accessible place, and cabin doors were unlocked. In fact the investigators conducting the survey could have started up, taxied out and taken off, in any one of numbers of aircraft, unmolested by the owners or their representatives.

There have of course been numerous unsuccessful attempts to steal aircraft. In one instance the magneto wiring was interfered with by someone obviously unskilled — apparently in an attempt to start the engine using a technique similar to that used to start a car without the ignition key. Though the attempt was unsuccessful, the would-be thief left the aircraft in the dangerous condition where turning the propeller by hand would have provided a spark from the magnetos — even though the ignition switch was off. It so happened that the owner's thorough pre-flight inspection discovered the damage before the aircraft was started.

Owners and operators are at all times responsible for the security of their aircraft — in just the same way that they are responsible for their house, car or any other possession, and the locking of ignition systems and doors are surely the most elementary measures. Of course some of our more elderly aircraft on the Australian register do not have lockable ignition switches, but owners would do well to explore the possibility of installing some form of lock to prevent the aircraft being started without authorisation. Also wherever possible, it is advisable to avoid parking in locations that are remote from surveillance. And on country properties, owners should ensure that fuel stocks kept in drums are also adequately secured.

Aircraft are no less liable to interference and theft than any other means of transport. Effective security can be achieved only if all owners, operators and pilots co-operate in providing and using the measures available to them. There will then be no need to introduce legislation of the kind now applicable to motor cars and other earth-bound vehicles.

Don't let this happen to your aircraft! The Cessna and the Hughes helicopter on these pages were stolen by would-be pilots whose enthusiasm exceeded their expertise.

Look, no engines

An instructor and his student were carrying out circuit training in a Cessna 310. During this particular exercise the instructor wished to demonstrate the critical performance of the aircraft should it suffer an engine failure on take-off combined with an undercarriage retraction problem.

To demonstrate this, the instructor 'failed' the right engine just after the aircraft had become airborne, using the mixture control. The student carried out all the correct emergency procedures other than raising the undercarriage, which the instructor had told him to leave down for the purposes of the exercise. All this was completed without difficulty and the aircraft, at an airspeed of 104 knots and with the right engine operating at zero thrust, continued to climb slowly away at about 50 feet per minute.

About half a mile beyond the end of the runway the instructor told the student to retract the undercarriage. But as the student began to do so, the instructor glimpsed something moving between the seats. It was the emergency undercarriage extension crank, and he realised that it had not been properly re-stowed after a previous exercise. The handle had turned about one revolution when the instructor saw it. He told the student to lock the handle, as otherwise the undercarriage would not retract. A few moments later the live left engine failed without warning, leaving the aircraft without power.

The instructor took control, telling the student to continue stowing the handle. He identified the failed engine and restored full power to the right engine. He then carried out a quick check and feathered the left engine as the aircraft was only just able to maintain height 150 feet above the sea.

Once the emergency crank had been stowed, the instructor retracted the undercarriage electrically and the aircraft began to climb. At a height of 250 feet, the instructor, feeling the situation was now less critical, carried out a trouble check to find why the left engine had failed. Checking the fuel, he immediately found that the left fuel selector (also located between the seats) was about half a centimetre out of its detent. He moved it back and then attempted to restart the engine. He had already decided that if he was unable to restart the engine quickly he would ignore it and continue for a landing on one engine. After priming however, the left engine fired easily, and so a normal landing was carried out on two engines.

It seems certain that the left engine failed because of fuel starvation caused by the fuel selector handle being out of its detent. Further, it appears that the student had accidentally knocked the selector out of position while he was stowing the emergency extension crank. In doing so, the student's fingers would have passed very close to the selector handle, moving in the direction in which it had been turned. However, he had no recollection of his fingers having contacted the selector.

Accidents caused by inadvertent interference with selectors or controls are by no means uncommon, and this incident shows again just how dangerous such interference can be in a critical phase of flight. These days controls and switches seem almost to fill the cockpits of twin-engined retractable undercarriage aircraft. Pilots therefore need to develop a continuing awareness of the vulnerability of these controls.

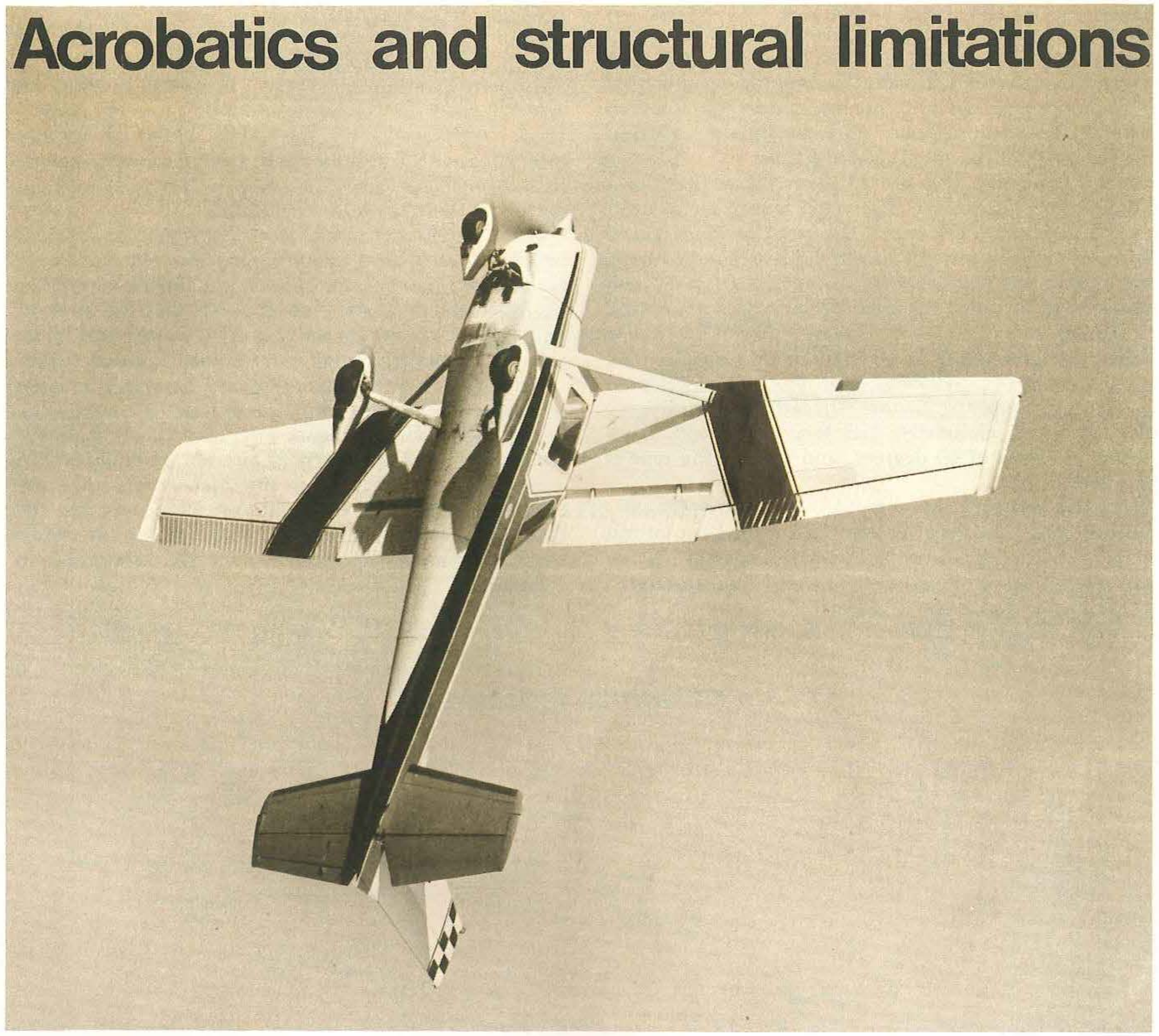
Wheels down—no light!

At the completion of a lengthy cross-country flight, the pilot of a light single engine aircraft selected the undercarriage down and prepared for landing, but the green DOWN lights did not appear. The undercarriage was cycled but still the pilot could not see the green lights. The pilot advised Flight Service of the situation and that he would carry out further checks clear of the circuit area. These efforts proved unsuccessful so the pilot made two low passes, one to the side of, and the other over, the Flight Service Unit. Observers on the ground confirmed that the undercarriage appeared to be down. Emergency services then stood by while the aircraft landed safely.

As frequently occurs in such cases, there was no fault in the undercarriage indicating system. The pilot had simply forgotten that when the navigation lights are turned ON, the indicator lights are automatically dimmed. On a bright day, such as existed at the time of the incident, it is very difficult to see whether or not the lights are illuminated unless they are at the normal illumination for day operation.

Talking in the crew room, or with their feet on the bar rail, few pilots would admit that they are not aware of this feature. Yet throughout Australia in the past year it has happened no less than 17 times! So next time you find your undercarriage position lights not illuminated when they should be, think about the automatic dimming facility applicable to your aircraft type!

Acrobatics and structural limitations



Several months ago the owner of a Cessna 177B became concerned about the structural integrity of his aircraft when he learned that it had been flown in aerobatic manoeuvres.

This type of aircraft is certificated in the normal and utility categories, and the flight manual lists the following manoeuvres as approved:

(a) Normal category:
Operations shall be limited to normal flying manoeuvres, but may include straight and steady stalls, and turns in which the angle of bank does not exceed 60 degrees. All acrobatic manoeuvres, including spins, are prohibited.

(b) Utility category:
No acrobatic manoeuvres are approved except those listed below:-

MANOEUVRE	ENTRY SPEED (I.A.S.)
Chandelles	100 knots
Lazy eights	100 knots
Steep turns	100 knots
Spins	Slow deceleration
Stalls (except whip stalls)	Slow deceleration

For operation in the utility category, the maximum take-off weight and the centre of gravity range are more restricted than the corresponding normal category limitations. The baggage compartment must be empty and the rear seat unoccupied. In the Cessna involved in the incident, a placard stating that the aircraft was certificated in the normal and utility categories, and giving entry speeds for the manoeuvres listed, was affixed to the cockpit roof.

The pilot who had hired the aircraft said later he believed he had complied with the flight manual, by limiting manoeuvres to spins and chandelles. But when he described the manoeuvres he had done, it was obvious that what he thought were chandelles were in fact, stall turns — manoeuvres which, if mishandled, could impose structural loads on the aircraft in excess of those for which it was designed. It was fortunate the pilot did not attempt a lazy eight, for when he was asked to describe this manoeuvre, he said he thought it consisted of two consecutive loops with a half aileron roll on the down side of each loop!

* * *

Aircraft are designed to meet the requirements of a particular operational category which, among other things, defines the basic strength of the airframe. It follows that the manoeuvres the aircraft may safely perform are determined by this basic strength. The positive load factor is usually the limiting case, but for some manoeuvres the limits are dictated by negative load factors. The categories into which Australian-registered aircraft are most commonly classified are:

Normal category. The aircraft is usually stressed for a 3.8 *g* positive load factor. The negative load factor must not be less than 0.4 times the positive load factor. Normal category aircraft are limited to non-aerobatic operations, but may perform unaccelerated stalls and manoeuvres in which the angle of bank does not exceed 60 degrees.

Utility category. Must be stressed for 4.4 *g* positive load and again the negative load factor must not be less than 0.4 times the positive factor. Aircraft in this category may do turns, chandelles and lazy eights with bank angles in excess of 60 degrees, and spins if the type is approved to spin.

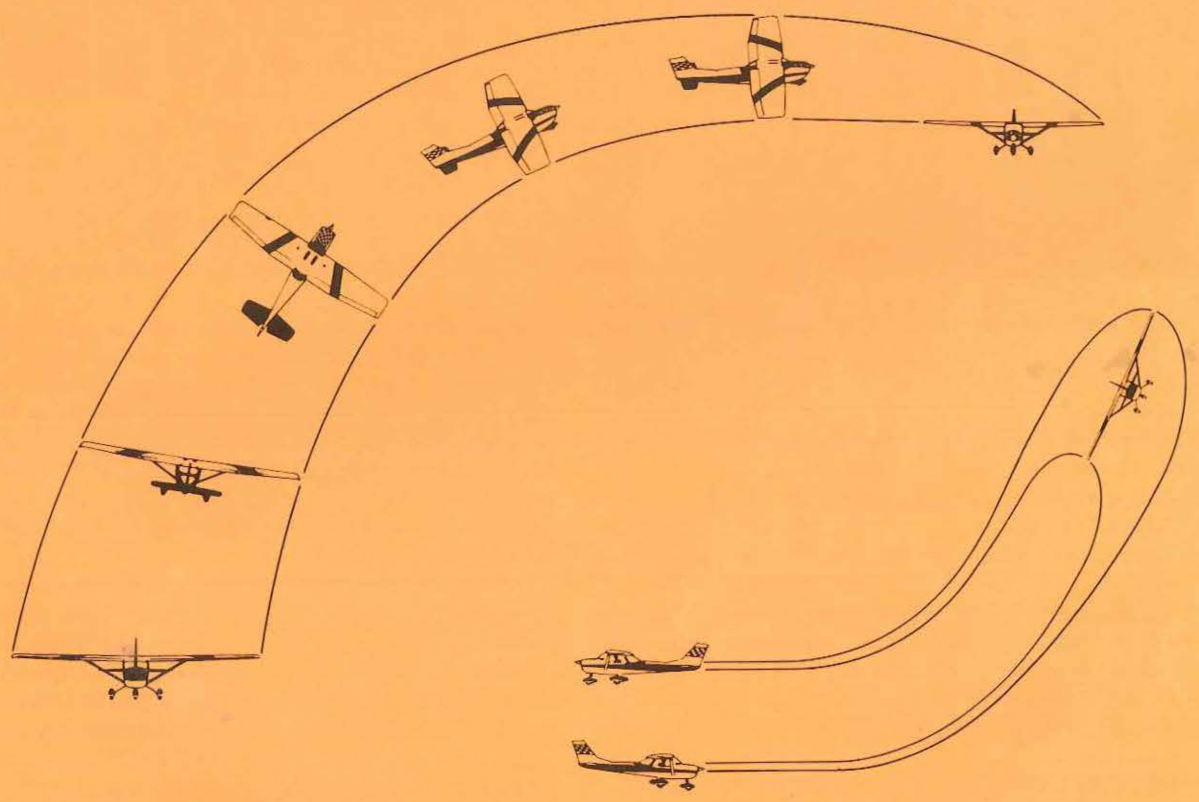
Acrobatic category. Must be stressed to at least 6.0 *g* positive load. The negative load factor must not be less than 0.5 times the positive factor. These aircraft may do any normal aerobatic manoeuvre that is not prohibited by the Flight Manual or by placard.

'Acrobatic' flight, as defined by the International Civil Aviation Organisation (ICAO), means 'manoeuvres intentionally performed by an aircraft involving an abrupt change in its attitude, an abnormal attitude, or an abnormal variation in speed.' The word 'aerobatic' is synonymous with 'acrobatic' and is the term most widely used. 'Acrobatic,' on the other hand, is usually associated with legislation and regulation, and appears in Australian Air Navigation Regulations and Orders in conformity with the ICAO definition.

No sensible pilot knowingly operates an aircraft beyond its structural design limits. The outcome could be disastrous not only for himself, but also for some other unsuspecting pilot who subsequently flies the aircraft. Unfortunately, because the names by which some of the various aerobatic manoeuvres are known differ internationally, and even nationally, there may be quite a number of pilots who are unwittingly subjecting normal and utility category aircraft to flight loads for which only acrobatic category aircraft are designed. To assist pilots in identifying the manoeuvres that are permitted or prohibited by aircraft flight manuals, the following common aerobatic manoeuvres are described under the names by which they are recognised in Australia.

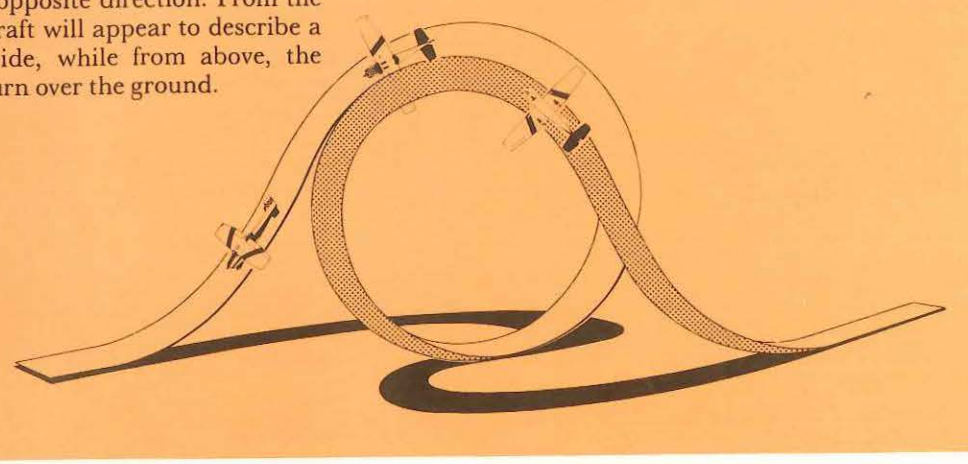
* * *

CO-ORDINATION MANOEUVRES



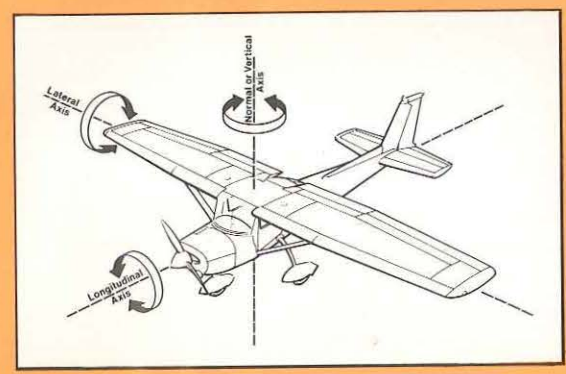
Chandelle — A balanced manoeuvre in which the aircraft performs a climbing turn on to a reciprocal heading. Entry is from wings level at or close to the manoeuvring speed, and exit is with the wings level just above the stalling speed.

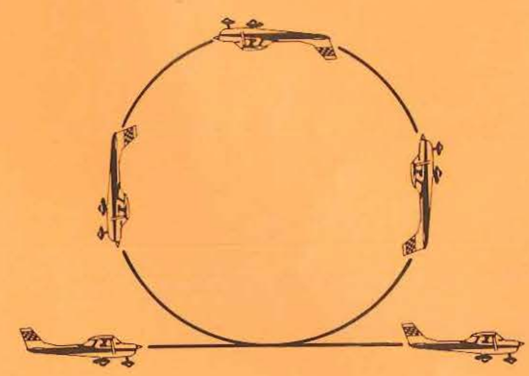
Wing-over — A balanced manoeuvre in which the aircraft, from level flight, performs a climbing and descending turn through 180 degrees, recovering at the entry height.



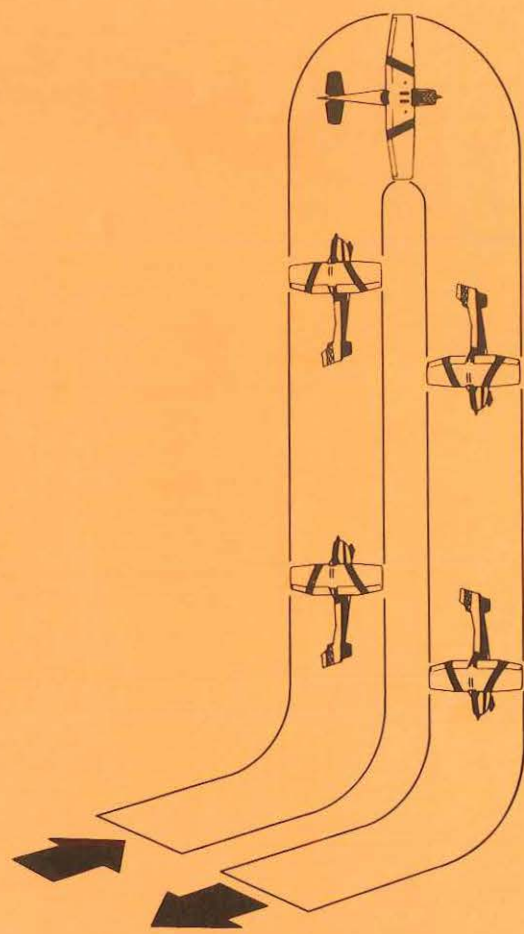
Lazy eight — A manoeuvre in which one wing-over is followed by another in the opposite direction. From the cockpit, the nose of the aircraft will appear to describe a figure eight lying on its side, while from above, the manoeuvre is seen as an S-turn over the ground.

BASIC AEROBATIC MANOEUVRES





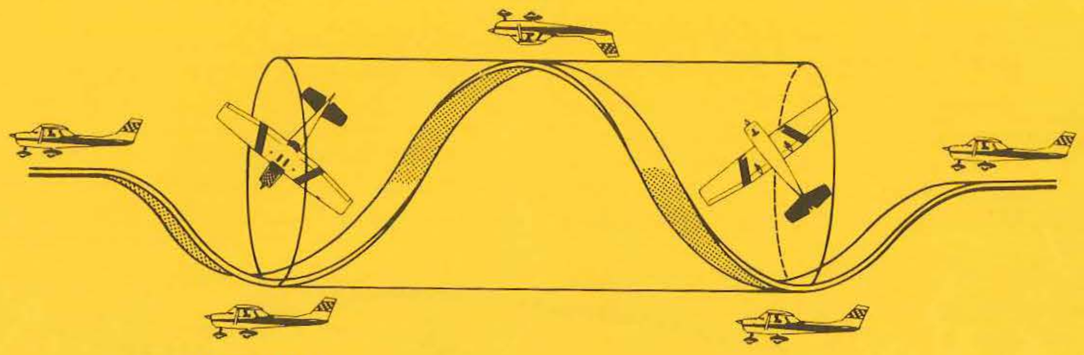
Loop
A balanced manoeuvre in which the aircraft follows a circular flight path in the vertical plane, with the lateral axis at all times parallel to the horizontal plane. The elevator is the primary control.



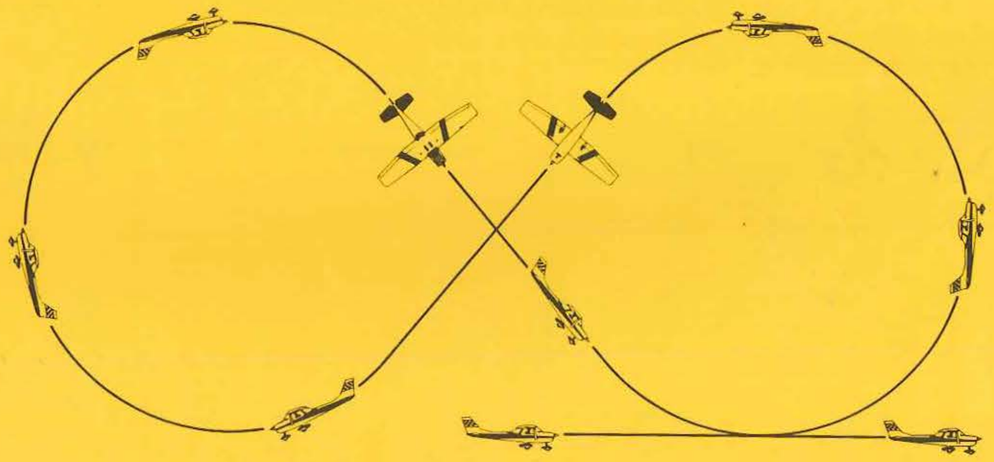
Stall Turn
A manoeuvre in which the aircraft enters a vertical climb, is yawed through 180 degrees about its normal axis with the wings level in the vertical plane, and then follows a flight path reciprocal to that of entry. The rudder is the primary control.

Roll
A manoeuvre in which the aircraft is rolled about its longitudinal axis (usually through 360 degrees from wings level to wings level), using aileron as the primary control.

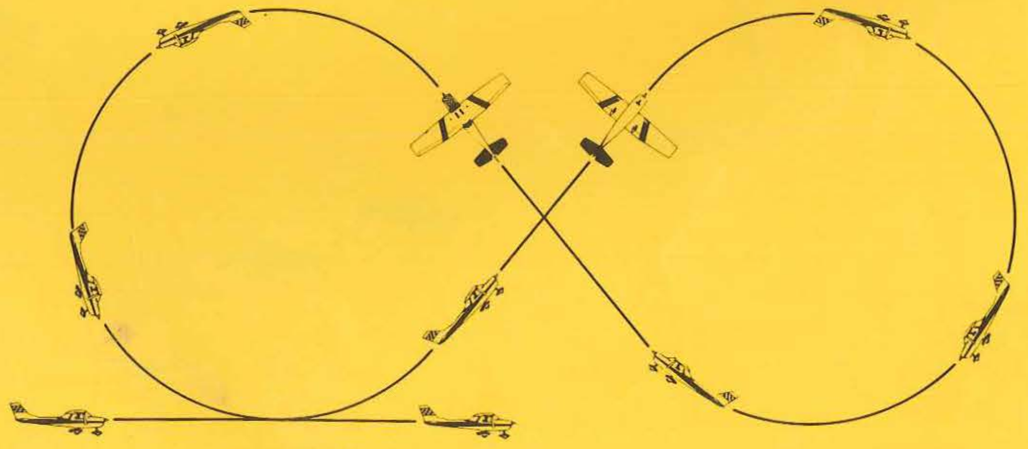
COMBINATION AEROBATIC MANOEUVRES



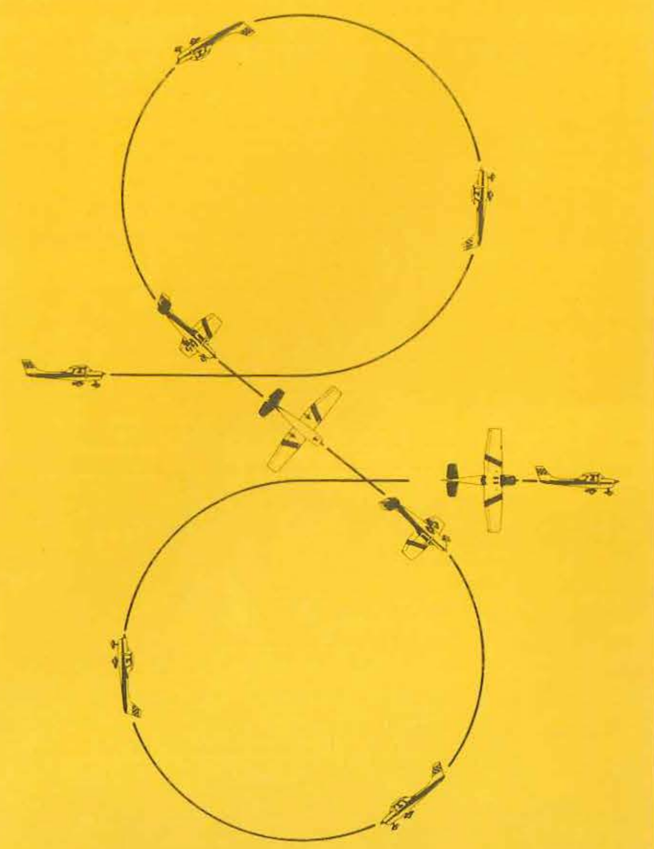
Barrel Roll
A balanced, positive *g* manoeuvre combining the loop and the roll, in which the aircraft flies a helical path about a horizontal line in space.



Cuban or horizontal eight
A vertical-plane manoeuvre in which the path of the aircraft describes a figure eight lying on its side. The aircraft performs a loop until the longitudinal axis is 45 degrees below the horizon on a heading 180 degrees to entry, then half rolls to perform a reciprocal manoeuvre. The tops and bottoms of both loops are at the same level.



Reverse Cuban eight
This manoeuvre is similar to the Cuban eight, except that the aircraft half rolls with the longitudinal axis 45 degrees *above* the horizon and loops downward rather than upward.



Vertical eight
A manoeuvre in which the aircraft performs an upward loop followed by a half roll and a downward loop, with entry and exit at the same level and in the same direction.

A number of variations can be applied to most aerobatic manoeuvres. Rolls can be slow, fast, hesitated, level, climbing, or descending; or combinations of these variations can be devised. A high performance aircraft can start a vertical eight at the bottom, do half a loop followed by a top loop sequencing into the last half of the first loop, and so on.

Training in aerobatics increases a pilot's ability to fly an aircraft accurately and to manoeuvre more precisely in all regimes of flight. To this end there is a good case for the use in pilot training of wing overs, chandelles and lazy eights to improve pilot co-ordination and judgement, and induce confidence in handling an aircraft in unusual altitudes.

Aerobatics can be fun and a most rewarding experience, especially if they are performed in a professional manner. Skill is obviously important, but so too is good airmanship. There are, of course, some basic 'rules' to be observed before venturing into aerobatic flight:

- The pilot must be certified by a rated flight instructor or other approved person as competent in the manoeuvres to be performed. The instructor or approved person may give instruction only in those manoeuvres they are certified to teach.
- The aircraft must be certificated in the utility or acrobatic category, depending on the manoeuvres to be performed.
- Aerobatics must be conducted in an appropriate area.
- A thorough pre-aerobatic check must be carried out, and updated from time to time throughout the sequence.
- A continuous lookout should be maintained.
- Each manoeuvre should be planned and the amount of airspace that will be required carefully anticipated.
- The pilot must be fully aware of his own limitations as well as those of his aircraft.
- He must exercise caution and commonsense.

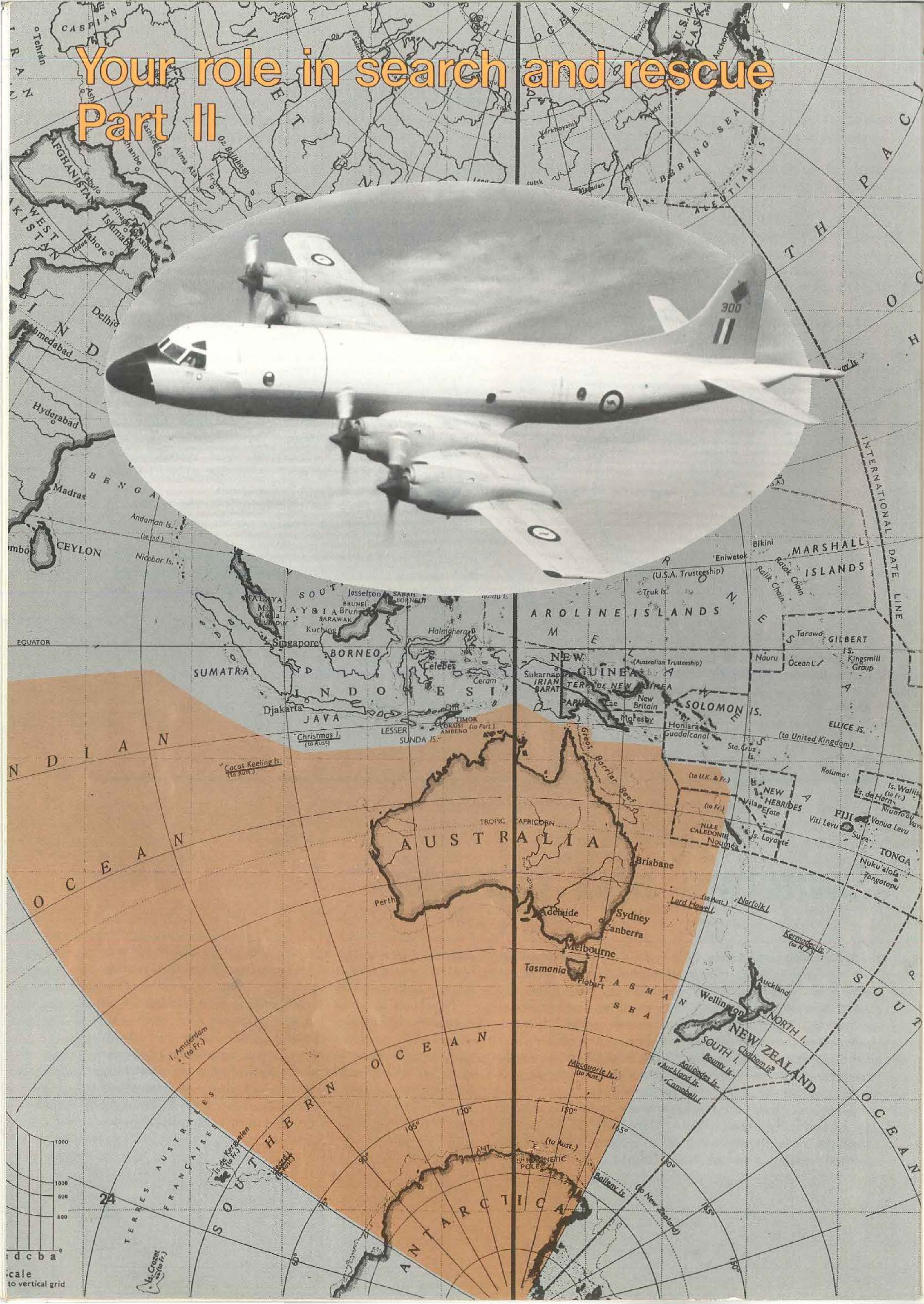
Switches and buttons

Approaching Cape Otway, Victoria, the pilot of a Cessna 207 en route to King Island attempted to pass a position report but could not make contact with Flight Service. Further checking revealed that there was no electrical power available. The Cessna returned to base where it was found that the alternator field switch had been left OFF. In this particular aircraft the field switch is remote from the master switch, and the pilot had apparently not monitored the ammeter during the flight.

In another case, the pilot of a Cessna 206 was unable to establish communications after take-off. Some 30 minutes were spent trying to overcome the problem, without success, so the flight returned to base. The instructor checked the aircraft, operated a couple of press button switches on the instrument panel and thus activated the audio selector box.

These are only two of 129 similar type incidents that occurred during 1976, in which pilots lost communication because they did not properly know the aircraft equipment. Returning to land and then finding that the fault lies with the pilot and not the equipment not only costs money but produces red faces. Both can be avoided by a little more time spent reading decals or ensuring you know what each switch, knob or button does — before take-off!

Your role in search and rescue Part II



This is the second part of a series of articles on Search and Rescue in Australia and how it concerns you as a pilot or aircraft operator. In Part I (Digest No. 101) we posed some questions which would probably spring to your mind if you were to become involved in a SAR operation. This part answers some of these questions as well as giving a brief outline of the Australian search and rescue organisation, its lines of responsibility and the way in which it functions.

The Air Navigation Plans of the International Civil Aviation Organisation (ICAO) divide the world into areas for which responsibility is allocated to an ICAO Contracting State. A similar situation exists with marine operations and, under the Inter-governmental Maritime Consultative Organisation (IMCO), maritime SAR is provided in geographic areas aligned as closely as possible to those of ICAO.

The area allocated to Australia is one of the largest in the world. It extends from between two and 10 degrees South, to the South Pole, and from 75 degrees East (2500 nautical miles west into the Indian Ocean) through 88 degrees of longitude to the mid-Tasman sea. It encompasses about 18½ million square nautical miles, — more than one square mile for each head of our population — and altogether nearly one eighth of the earth's surface.

Almost every possible type of environment is found within this area, from tropical jungle to pastureland plain, from parched desert to icy polar waste and of course vast tracts of ocean.

Major air routes cross the continental and oceanic areas for which we are responsible and busy shipping lines operate to and from major ports around our coast. Domestic aviation of various kinds operates throughout the country and across Bass Strait, while marine coastal traffic and fishing vessels, together with yachts and a wide range of pleasure craft, ply the entire coast. The total number of these movements runs into hundreds of thousands. On the land also there has been a dramatic increase in bush walking and other related outdoor activities, and parties of school children camp frequently in our national parks.

Any of these activities, in any environment and at any time, may generate a search and rescue action. The costs associated with permanently maintaining personnel and equipment to provide such an enormous SAR coverage would obviously be immense, and to cope with the situation a system has been developed by the various Australian SAR authorities that is to a large degree based on mutual co-operation.

There are three recognised SAR authorities: the Department of Transport, the Department of Defence, and the police forces of the various States and Territories. These are assisted from time to time by various volunteer groups which have been formed throughout the country and are supported by either interested local groups or charitable organisations.

Within the Department of Transport there is both an air and marine SAR element. For air operations, the Department maintains ten Rescue Co-ordination Centres, each serving the Search and Rescue Region in which it is located. In addition there are six sub-centres available for immediate manning should a SAR action become necessary in a remote area.

These centres are manned by Operational Control officers trained at the Department's Search and Rescue School at its Central Training College in Melbourne. On completion of an intensive seven weeks' course, officers graduate as SAR Mission Co-ordinators or Assistant SMC's according to the level of expertise demonstrated and the depth of experience attained. These officers have the responsibility of co-ordinating search and rescue activity for missing civil aircraft as well as for air searches for missing vessels made on behalf of the Department's marine element.

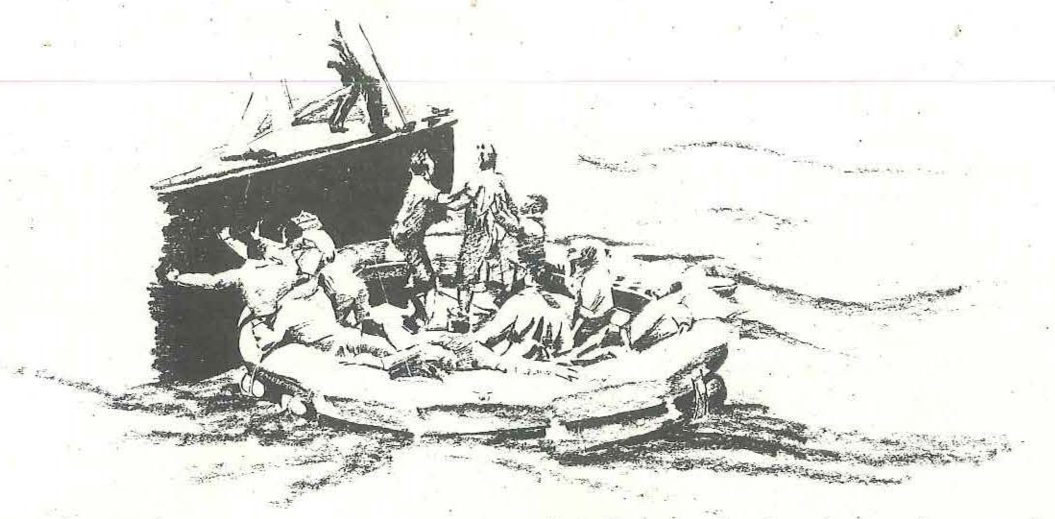
The SAR course at the Department's Central Training College is based on the syllabus used by the United States Coast Guard in its training school at Governors Island, New York, but has been extended to cover the special conditions encountered in the Australian environment. In addition to the Department's air and marine SAR personnel, the school trains officers from each of the Defence forces and from State and Territory police forces, as required. Standardisation is thus ensured amongst the various authorities concerned and each has a working knowledge of the functions, responsibility and expertise of the others.

Departmental marine search and rescue responsibility is discharged through the Marine Operations Centre, a central facility located in Canberra. It is responsible for all ships operating under the Australian Navigation Act, including all vessels engaged in international or interstate trade or commerce. In addition to the SAR function, the Marine Operations Centre handles the Australian Ship Reporting System (AUSREP), broadcasts of navigational warnings (a marine equivalent of our NOTAMs) and the co-ordination of coastal surveillance.

The role of the Department of Defence in the SAR organisation is that of providing SAR for missing land, sea or air units of our naval, military or air forces. However it also plays a significant role in the civilian area by providing facilities wherever possible to assist in specialised tasks. In many instances, particularly those at sea, the only suitable aircraft in terms of range and navigational capability are those of the RAAF. The Department of Transport, though bearing the overall responsibility for such a SAR action, relies heavily on the Department of Defence for this assistance.

The third SAR authority in Australia is made up of the police forces of the various States and Territories. Basically their responsibility is for persons lost on land such as bush walkers and hikers, and for the rescue of people involved in boating accidents close to the coast.

As already mentioned, Australia does not maintain aircraft or crews exclusively for SAR operations. Instead the most suitable available aircraft are called upon for the task in hand. Clearly in the long-range oceanic case, the most suitable aircraft are those of the RAAF. However, in a search close to the coast or in inland areas, it is often preferable to use local operators. Not only do their pilots know the area, but they are usually more readily available and the type of aircraft they operate is usually the best for local conditions. For instance, in mountainous country it is often better to use a high-wing light aircraft which will afford the best visibility as it banks and turns around the contours of the hills. Similarly, a local operator's light twin-engined aircraft is often the better choice for a search for a missing boat, especially when the positioning of a military aircraft from a base such as Edinburgh or Townsville would be



time-consuming and expensive.

Among the most common SAR actions are those relating to boating accidents close to the coast, and civil pilots quite frequently become involved in this type of search. Sometimes the police use their own aircraft, but more often an aircraft is chartered to carry out a surveillance flight. In this situation the flight is a normal charter operation and is required to conform to the usual charter requirements.

In most cases a search aircraft is organised through the appropriate Rescue Co-ordination Centre. In this instance the request for the aircraft will originate from a rated SAR Mission Co-ordinator who has the authority to initiate the air search, to vary the requirements of certain of the Air Navigation Regulations in order to facilitate the search, as well as to authorise expenses incurred in it.

Under various Commonwealth-State agreements, the Australian Government provides assistance to State or Territory authorities when an emergency situation warrants facilities that are beyond the capability of the State. Thus when State police authorities are confronted with a wide-scale search for a missing vessel, they may approach the Department of Transport to assist with expertise, facilities and finance. Initially the State request is directed to the Department's Marine Operations Centre (MOC). Upon receipt of such a request, MOC assumes responsibility for the overall co-ordination of the SAR action and will review the area to be searched, taking into account ocean currents, drift factors, winds and all available intelligence.

MOC will warn surface vessels of the situation and organise a surface search. If, as is usually the case, the area is so large that it must also be searched by air, the MOC will pass the air search responsibility to one of the Departmental RCC's. The duty SAR Mission Co-ordinator will then decide on the most suitable aircraft for the task, taking into account location, availability of crews, range, visibility potential, supply drop capability (if necessary), and other such factors.

The SAR Mission Co-ordinator then advises the aircraft operators and crews of what is required and prepares appropriate briefing material for them. From this time onwards the RCC is responsible for all civil aircraft involved in the search and for such matters as operational control, separation from other aircraft, crew hours, search patterns, altitudes, track spacing and crew accommodation.

One of the prime functions of a SAR operation is of course that of survivor rescue and a mission is not deemed accomplished until all survivors are returned to safety. Between the time that survivors are first located and when they are picked up, a number of steps may have to be taken.

Basically the task is simply to pick them up. Normally this is carried out by a land party if the survivors are on the land, or a ship if they are in the water — or in some instances by a helicopter. But in many cases survivor retrieval is anything but a simple straightforward task and some time may elapse between the original sighting and the pick-up. For this reason the Department maintains droppable equipment which will sustain the survivors throughout that period.

Droppable equipment is strategically located at centres throughout the country. It consists of water supplies, supporting rations (for both land and marine situations), first aid kits, signalling and communications equipment, as well as flotation equipment such as life-rafts and life-jackets. Specially constructed dropping boxes and containers have been developed for delivering the equipment to survivors. Normally a 'Helibox' is dropped over land and marine rescue kits are dropped to persons in the water. There will be more on this topic in a later issue.

Supply dropping can be conducted only from aircraft approved for the purpose and necessitates specific approval for flight with the doors open or off. If a marine kit is to be dropped, an exact flight procedure must be used and, because several pieces of equipment are roped together and despatched in sequence, the dropping of this equipment should not be attempted by untrained personnel.

The Department has specially qualified 'Dropmasters' located at aerodromes at which marine rescue equipment is held. There are also ATC staff who can give an untrained pilot detailed briefing on the flight patterns to be flown and the signals he will be given to ensure accurate delivery of the equipment. The ATC officers will accompany the pilot and assume responsibility for despatching the equipment and the associated cabin safety.

In addition to the RCC staff and Dropmasters, the Department have available qualified Observer Leaders and Observers. Volunteers for this purpose are drawn from various areas within the industry and all have been trained in observation techniques most likely to be successful. These observers are allotted to the pilot as part of his search crew, at the discretion of the SAR Mission Co-ordinator.

The next part in this series will discuss 'How search areas are calculated'.

Frost, ice and snow

Warnings about the danger of taking-off with ice or snow on the wing or tail surfaces of an aircraft are of limited application in Australia. However, a seasonal reminder of the aerodynamic effects of even a thin coating of frost could be timely for all pilots.

As pointed out in previous issues of the Digest, although a coating of frost hardly affects the aerofoil shape of the wing, the frost's surface roughness increases drag, destroys the smooth flow of air over the aerofoil and raises the stalling speed by promoting early airflow separation. For this reason, an aeroplane coated with frost can fail to become airborne at the normal take-off speed and, even if it does manage to struggle into the air, the margin of airspeed above the stall will be lessened so that only a medium turn or moderate turbulence can be sufficient to induce a stall.

The main effects of ice or snow on an aerofoil are to disturb the normal airflow over its surface and to alter the distribution of weight. This can result in increased drag, loss of lift, decreased control, flutter of the surface or all of these factors combined in varying degrees. The vital factor is the distribution of the ice or snow formation on the surfaces, rather than the additional overall weight increase to the aircraft. The formation of ice or snow creates changes in aerofoil contour, and control and servo-tab surface mass imbalance, which may lead to separation of airflow and in some extreme cases, dynamic instability of the surface.

If the ice formation is asymmetrical, large differential loads between two lifting surfaces may develop to a point that the aircraft can no longer be controlled. Ice formation on the leading edge of a control surface or servo-tab also creates a potential buffeting condition. This is particularly true at surface deflections where the iced portion of the control surface leading edge protrudes above or below the trailing edge of the primary surface.

For those who require evidence, the following accident and incident reports are reproduced from a brief published by the Aeronautical Research Institute of Sweden:

- A twin-engine STOL aircraft went into an outside loop when the flap was lowered. Cause: Ice at the leading edge of the tailplane resulted in tailplane stall. The aircraft 'recovered' upside down after a 180 degree 'bunt'.
- The crew of a twin jet transport almost lost pitch control as a result of tailplane icing when flap was lowered during their approach to land. Flow separations caused by the ice had large effects on trim and pitch control effectiveness.
- A light twin propeller-driven aircraft lost altitude and crashed after lift-off. Cause: Frost on wing combined with wind shear. Frost can increase the stalling speed by as much as 20 to 30 per cent.
- A medium-sized twin jet transport rolled to the left immediately after lift-off. The pilot saved the day by resettling the aircraft on to the slippery runway and continuing acceleration to a higher take-off speed. A successful lift-off was finally made near the runway end. Cause: Patches of snow sticking to the left wing. The wings had been brushed clean but the person sweeping the left wing had not removed the compressed snow from his own foot-steps!
- A swept-wing twin jet pitched up after lift-off. The crew pushed the control wheels 'into the instrument panel' to prevent a stall. Cause: Frozen snow on the wing surface near the wing tips resulted in early wing-tip stall, shifting the lift force resultant forward and producing a high risk of over-rotation.
- A light twin-engine propeller-driven aircraft used twice the normal take-off distance, then stalled at lift-off. Cause: Ice frozen under light snow on the wings increased both drag and stalling speed. The pilot had brushed off the snow but had let an 'insignificant' amount of ice remain on the upper wing surfaces.
- A light single engined aircraft 'mushed' back on to the ground after lift-off. Cause: Ice on the upper wing surface. The pilot believed that light snow would blow off the wing but forgot that aircraft was warm when taken out of its hangar. The snow closest to the wing surface melted, then refroze on the wing.

In regions where such climatic conditions prevail, aircraft should be thoroughly examined for ice and snow deposits just prior to flight to ensure that:

- All skin surfaces are clean and entirely free of frost, ice and snow.
- Propeller blades and hubs are inspected and any frost, ice or snow is removed.
- All control hinge points and control surface openings are checked for freedom from ice and snow.
- All antennae and antenna fittings are free of ice and snow deposits.
- Nose and main undercarriage assemblies, including drag linkages, up-latches and door operating linkages, are clear of ice and snow.
- All heater and supercharger air intake duct openings are clear of snow and ice deposits.
- Engines are warmed-up in an area free of slush and moisture, lest the propellers pick it up and throw it back over the wings, tail surfaces and fuselage.
- After engine warm-up, all flight controls are checked through their full range of travel to make certain that they are not restricted by packed ice or snow in areas where visual inspection is difficult.

Birdstrikes

The majority of collisions between aircraft and the birds with whom we share the sky do not result in significant damage to the aircraft. Since the beginning of man's airborne adventures, however, birdstrikes have occurred frequently enough for concerned aviation authorities throughout the world to investigate the hazard posed by such collisions and to conclude that measures are necessary to reduce the effect of them.

The first recorded fatal aircraft accident resulting from a birdstrike occurred in 1912 when a seagull became enmeshed in the control cables of a Curtiss Flyer. Since then birdstrikes have led to several fatal aircraft accidents; the one with the greatest loss of human life being the crash of an Electra which encountered a flock of starlings on take-off from Boston U.S.A. in 1960 in which sixty-two of the seventy-two occupants were killed.

In Australia there has not been a fatal civil aircraft accident attributed to a birdstrike though there have been several accidents in which the aircraft was substantially damaged. In December 1969 a Boeing 707 abandoned take-off at Sydney Airport after encountering a flock of seagulls. The aircraft overran the runway and the landing gear was torn from the fuselage. Though there were no injuries to the 136 occupants of the aircraft, the substantial airframe damage required extensive repairs.

The pilot of a Piper PA25 aircraft engaged on agricultural operations would also testify to the potential danger of birdstrikes. While spraying a crop in Western Victoria during November 1977 the aircraft struck a wedge-tailed eagle which appeared to be attacking the aircraft. The bird had a wing span of two metres. After dumping the remaining spray, the pilot checked the aircraft for controllability and then landed at the nearby agricultural strip. The outer portion of the left wing was severely damaged by the birdstrike.

Reduction of the birdstrike hazard has responded in the past to two particular approaches

— constructing aircraft to withstand birdstrikes
— separating aircraft and birds

Strengthening aircraft components to withstand birdstrikes inevitably results in an increase in an aircraft's weight with a consequential decrease in its performance and payload. Therefore before such requirements are imposed on manufacturers and operators, it is necessary to establish clearly all of the factors involved in birdstrikes. The types of aircraft and birds, the aircraft speed and altitude at which strikes occur, the phases of flight of the aircraft at the times of the strikes and the nature and extent of the damage resulting need to be collated to form the basis for specifications for aircraft airworthiness criteria.

In 1965 ICAO requested Member States to contribute to a program of reporting all birdstrikes so that the necessary information was available to the organisation's Airworthiness Committee concerned with developing airworthiness standards. This information led the Organisation to develop revised airworthiness standards for airframes and engines of aircraft over 5700 kg maximum gross weight. Recently in the United Kingdom the revised airworthiness requirements were extended to apply to all aircraft manufactured in that country. Aircraft components constructed to meet the revised standards improve the damage tolerance of modern aircraft to the effects of birdstrikes.

Revision of the airworthiness standards however does not assist in reducing the frequency of bird strikes. To do this ways of separating aircraft and birds need to be found. Data already gathered on birdstrikes shows that most occur in the vicinity of aerodromes, where aircraft are at low altitudes and in the environment where birds spend the majority of their time. Clearly, then, efforts to achieve separation between birds and aircraft need to be directed to the aerodrome and its vicinity.

Australian experience has shown that a combination of correct environmental management techniques to reduce an aerodrome's attractiveness to birds, combined with the use of bird dispersal devices can significantly reduce the birdstrike problem. Sydney Airport is an example where the closure of nearby rubbish tips, the improvement of airport drainage and the operation of mobile bird dispersal patrols have resulted in a greatly reduced birdstrike risk.

To select and apply effective bird control techniques nationally it is necessary to acquire detailed knowledge about the bird characteristics and behaviour at each individual aerodrome. Variations in the environment of different aerodromes can result in varying numbers of species of birds inhabiting the aerodromes. Clearly there are differences between the bird populations and behaviour at Hobart and Alice Springs. Local factors such as the presence of water, crops, abattoirs etc. in the vicinity of an aerodrome can also affect the pattern of bird species and movements found on and around the aerodrome.

Though in the preceding paragraphs we have been discussing birdstrikes in the vicinity of aerodromes, the Department's interest in the subject is not confined to such strikes. We are interested in birdstrikes occurring in all circumstances and involving all categories of aircraft — airline, general aviation, reciprocating and turbine powered. If information on all birdstrikes is available, it may enable geographical and seasonal patterns of bird movements to be established so that pilots may be warned what to expect from birds and steps taken to separate the birds and aircraft.

This article, and the poster opposite, introduce a Departmental campaign to improve the reporting of birdstrikes in Australia. The airlines and the Australian Federation of Air Pilots have pledged their support, and we are seeking support from all other sections of the aviation industry in a combined effort to reduce this hazard by better understanding of the problem.

Special birdstrike report forms have been printed for the campaign. Three different forms are used

— for pilots to report details such as the type of aircraft involved, speed, altitude, phase of flight etc.
— for Airways Operations personnel to provide details of weather, etc.
— for the Airport ground personnel to report on bird carcasses recovered, the runway location, possible sources of attraction for birds, and other pertinent information.

Pilots are urged to complete their form whenever they experience a birdstrike. The forms can be obtained at flight briefing offices during the campaign and completed forms may be lodged at any Airways Operations Unit.

The solution to the problem of birdstrikes lies in the analysis of the data reported. Each report provides additional data on an aerodrome's bird species and habits. When all such reports are analysed location by location over a period of time the particular problem at each location may become evident. The Department is utilising computer facilities to collate recorded birdstrike information so that the data obtained therefrom can be easily stored and readily retrieved for analysis. This will be done and specific studies initiated and conducted by specialist officers within the Department. The need for corrective measures will then be determined and appropriate action taken to reduce the birdstrike hazards identified. Bird Hazard Committees have been established in Central and Regional offices of the Department to coordinate the campaign and the remedial action.

This campaign is a sustained effort to gather information from which the extent of the hazard presented by the Australian bird population to aviation may be assessed. The success of the campaign requires the full participation of all readers of the Digest. Your assistance in this regard by reporting all birdstrikes you encounter will help ensure this success.