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Aviation Safety Digest

Department of Transport

Contents

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Editor's note

Photographers and artists amongst our readers are invited to submit material suitable for the cover of the *Aviation Safety Digest*. Illustrations of modern general aviation or airline activities will be favoured. Credits will be given for any photographs or artwork selected for reproduction.

Beware of dehydration

While studying for a Commercial Pilot licence, the pilot accepted the opportunity to ferry a Cessna 210 aircraft from Adelaide to Tom Price, in north western Australia. Although relatively inexperienced, with less than 150 hours total flight time, she saw this as a chance to build up her flying hours.

The flight was planned for mid November, with refuelling stops at Ceduna, Kalgoorlie and Meekatharra, remaining overnight at Kalgoorlie. The first day's flying was completed without incident, although the pilot did establish that the radio compass was unserviceable and she was required to navigate by DR and visual reference. On arrival at Kalgoorlie the pilot arranged to refuel the aircraft at 0730 hours the next morning.

She spent the night in a hotel and early next morning, when she went for breakfast, she was told that, because of a power strike, breakfast would not be available until 0800 hours. Rather than disrupt the refuelling arrangements, the pilot chose to have only a cup of tea and then went to the airport.

The aircraft was refuelled and departed Kalgoorlie just after 0900 hours. The pilot had not obtained any further food or drink and there was neither rations nor water on board the aircraft. After an uneventful flight of about two and a half hours, the aircraft landed at Meekatharra. Less than an hour later it had been refuelled and departed for the final leg to Tom Price. No refreshments were obtained by the pilot at Meekatharra.

Shortly after take-off, the pilot realised that she had made an error of 100 degrees on the flight planned track (248 instead of 348) so she altered the aircraft heading by the same amount. The pilot did not realise at the time, however, that application of the forecast wind of 090/15 to the correct track did not produce the same amount of change to the heading. As a result the aircraft was seven degrees left of the correct heading. The expected groundspeed had also been reduced below the flight planned figure.

The first checkpoint, 110 nautical miles along the route, was a homestead in relative featureless terrain. This was missed and the pilot, believing the aircraft to be right of track, altered heading 12 degrees to the left. At 1350 hours, when she estimated the aircraft to be 30 miles from Paraburdoo, the pilot broadcast an 'all stations' call which was received by another aircraft departing from that location.

By this time the pilot of the Cessna 210 had become quite unsure of her position. Because of poor communications, the other aircraft acted as a relay for messages to Port Hedland Flight Service Unit. The combined efforts of Airways Operations and the other pilot were unable to fix the position of the Cessna. At 1518 hours, after the declaration of an Alert phase, the pilot was instructed to land at a station strip she had been circling.

After a successful landing the pilot reported that she was at a homestead about 80 miles west of Paraburdoo. Because accommodation was considered to be unsuitable the pilot decided to fly to Paraburdoo before last light. She drank half a cup of brackish water while flight planning and then departed at about 1700 hours.

There were thunderstorms in the area and about four oktas cloud cover, the shadow of which made navigation difficult. Half an hour after departure, at the ETA for Paraburdoo, the pilot again became lost but could see a homestead below. A Distress phase was declared and about 20 minutes later the pilot reported that because the aircraft was low on fuel she was landing at the station strip.

The aircraft was flown about 30 knots fast on the approach and ultimately touched down about half way along the 730 metre strip. Heavy braking was applied but the aircraft ran off the end and overturned in a ditch. The pilot, fortunately, was uninjured. The accident had occurred at a station about 50 miles south west of Paraburdoo.

After the accident the pilot was taken to the homestead where she consumed a large quantity of water. A commercial pilot who was there considered her to be 'all in'. She was very distressed and self-critical about the fact that she had twice become lost.

It was obvious from the circumstances of the flight and the accident, and the condition of the pilot, that she suffered from the effects of dehydration. Symptoms to be expected with dehydration include extreme thirst, headache, dizziness and disorientation. Navigational difficulties, fatigue and the apprehension experienced by the pilot would be related to that condition.

The temperature at the accident site at about 1800 hours was 36 degrees Celsius so it can be assumed that through the day the temperature must have reached at least 40 degrees. It is probable that the cockpit of the aircraft was even hotter because of the 'green house' effect.

At rest, with an ambient temperature of 40 degrees, a person can expect to lose 3.26 kilograms per day as the result of sweat loss. Authorities agree that, for survival in arid areas with an average daytime temperature in excess of 32 degrees, the body needs four litres of water per day. This is considerably in excess of the cup of tea and half a cup of brackish water consumed by the pilot on the day of the accident. It is probable that her water consumption on the previous day was also well below the required amount.

Dehydration

Dehydration is a severe imbalance of the water content of the human system — a common, but not usually serious, summer complaint for most people. However, for pilots who fly in spite of feeling obviously below par, dehydration can impair flight performance to the extent that a serious accident can result.

Land animals evolved from water dwelling creatures and in that evolution retained the water environment but enclosed it within the skin. The human body is over 60 per cent water by weight; about seven per cent of the total body water is utilised as circulating fluid (blood plasma), with 33 per cent bathing the body cells and 60 per cent contained within the cells. We are dependent upon this fluid for all physiological functions; food and oxygen are dissolved and carried to the cells, waste products are carried away, and the very chemical reactions of life itself occur in water solution. This body of water is not static. There is a constant flow from the cells into the body and back, as well as exchange of water with the environment. The body takes advantage of normal losses of water to the outside world for elimination of wastes by way of the kidneys, and for cooling by evaporation from the skin and lungs. These normal losses are balanced by drinking water. It is only when the losses are greater than the intake that dehydration occurs.

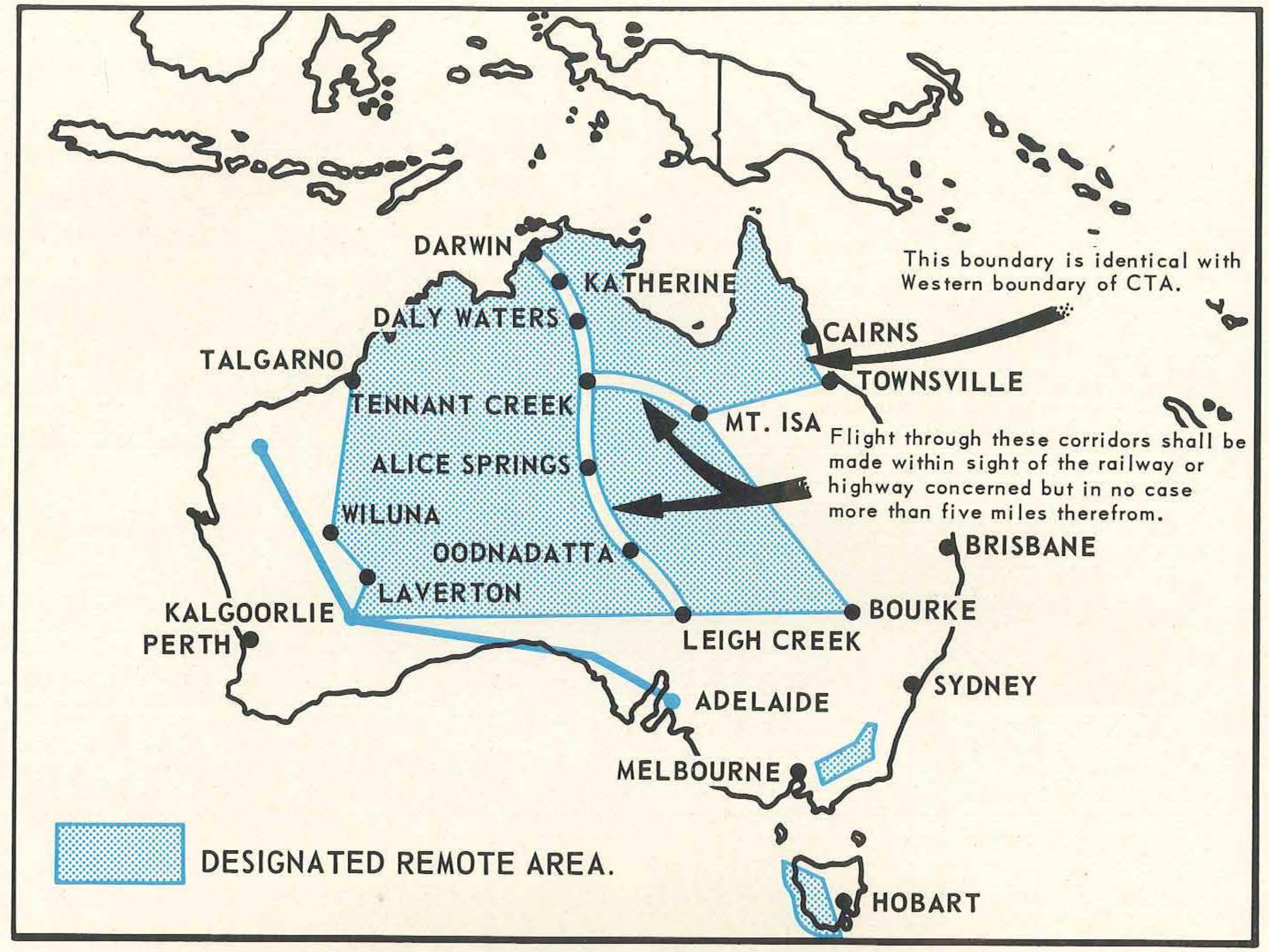
The symptoms of dehydration include headache, weakness, drowsiness, nausea and impaired vision. Speaking distinctly and movement of any kind may seem to require great effort. Water loss amounting to only two per cent of body weight (about a litre) will cause symptoms. A significant salt loss with dehydration can result in muscular cramps anywhere in the body. The condition known as heat exhaustion is a state of collapse brought about by insufficient blood supply to the brain, following a period of heat stress. Heat exhaustion can occur at water losses as low as six per cent of body weight.

The association of flying and dehydration is based partially upon the exposure of the human body to lowered atmospheric pressures. When the atmospheric pressure decreases, water evaporates from the body at a higher rate. Rates of loss have been studied at various altitudes and, even at cabin pressures of 5-10 000 feet, evaporation is significantly increased. Under normal operating circumstances this loss is small, but under conditions of prolonged flight the loss becomes very significant in the absence of adequate water replacement. This loss will be greatly increased if cabin temperatures are high or if the atmosphere is particularly dry — as it is at altitude.

Individual tolerance to dehydration varies, although it is a well established fact that no one can live much beyond three days without water. No pilot should attempt to fly an aircraft directly after any prolonged activity in the sun that may have had dehydrating consequences. Even where no obvious debilitating effects appear, a loss of mental initiative can be expected, and this is not a good frame of mind for safe flying.

It is recommended that you incorporate the following items into your flight planning for this and every other Australian summer, or when flying in the hot, dry conditions which can be encountered in outback areas even during the winter:

- Maintain a high body fluid level by regular intake of suitable liquids. This can be supplemented by taking along a thermos of cool water in the aircraft and drinking frequently. Cool water is preferable to iced water as it is easier to drink. The body effectively loses more heat by warming the cool water to body temperature. Realise that you lose moisture constantly when you are out in the sun or warm air, even when you are unaware of sweating.
- Use normal salt with your meals, but check with a doctor before taking salt pills. Some people have bad reactions to them. Extra salt is seldom required unless the individual is engaged in heavy manual labour in the sun.
- Recognise that caffeinated drinks (tea, coffee, cola) tend to stimulate loss of water.
- Avoid letting your aircraft cockpit be turned into an oven by the sun. If you are unable to park it in a hangar or in the shade, try to cover the upper windows with a tarpaulin.
- Take time to open air vents before taxying.
- Be aware that dehydration can be accelerated by pre-flight activities — for example, it may well overtake a pilot in flight after a day's fishing in an open boat, if water loss has not been replaced. Vigorous exercise in hot weather also speeds up the loss of water tremendously. The sweat rate of men doing heavy work or playing a hard game of sport under very hot conditions can be over two litres per hour, and the concurrent salt loss may be equivalent to a normal day's intake.



It was extremely fortunate for this pilot that the accident occurred on a property with help close at hand. If she had been forced down away from civilisation it is extremely doubtful that, in her condition and lacking any supply of water, she could have survived until a rescue party arrived.

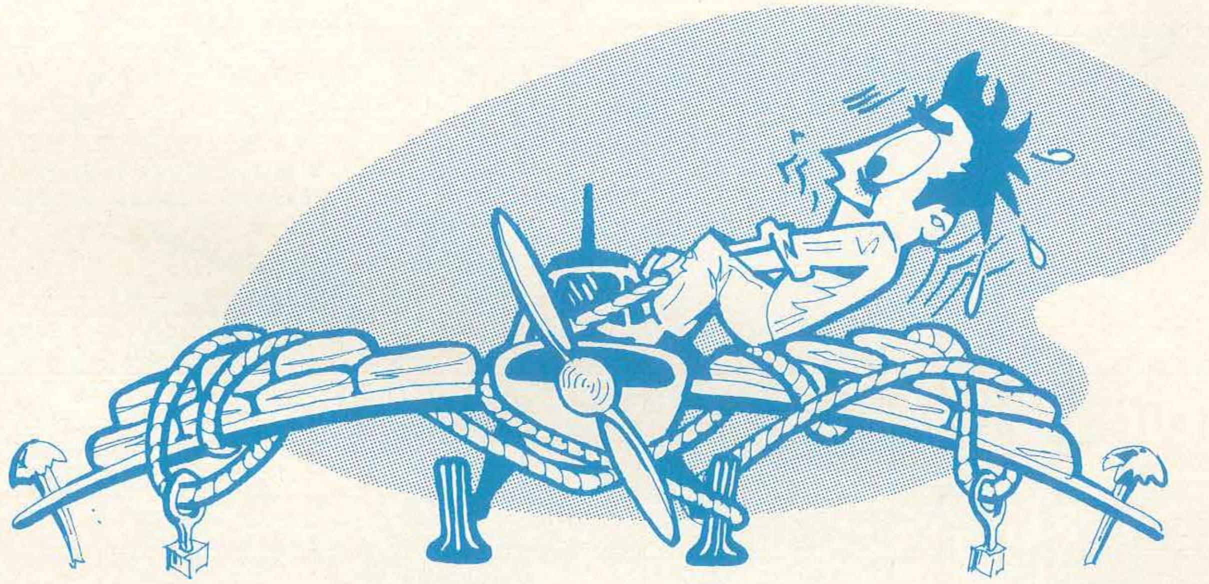
The AIP VFG discusses the requirements applicable to flight in designated remote areas. However, it is not only in these designated areas that hazardous conditions and situations can be encountered. Before undertaking any such operation be sure that you are mentally and physically prepared. Read up on survival and ensure that you carry adequate food and rations for the occupants of the aircraft until help arrives, in the case of an emergency. Seek guidance from experienced personnel if you are unsure of the safe way to embark upon your trip. Ensure that you maintain an adequate fluid intake to retain your mental processes at a peak. If you do this you will be less likely to finish up in a survival situation.

Although not through a Designated Remote Area the planned route was over arid, sparsely inhabited country. Planning for this flight should have obviously included consideration of the normal needs for food and water as well as preparation for the possibility of a survival situation arising. ●

Visits to Airways Operations units

The Department regularly receives letters from members of the aviation industry who are interested in visiting Air Traffic Control and Flight Service units to learn more about their functions. Visits to units appropriate to the individual's normal area of operations are encouraged. To arrange such visits interested persons should contact the Superintendent of Airways Operations at the applicable regional office of the Department of Transport, or the officer in charge of the specific unit he wishes to visit ●

Tie-down sense



Each year aircraft are needlessly damaged by high winds and storms because of negligence and improper tie-down procedures. There is no doubt that Mother Nature can turn the aircraft parking lot into a junk yard in a matter of minutes. Whether you are willing to admit it or not, if your aeroplane, or one for which you were responsible, has been damaged in such circumstances, the chances are that it was improperly secured, or not tied down at all. In an attempt to correct the situation this article is intended to improve your knowledge on the correct way to tie down an aircraft.

Preventing damage

The best protection against storm damage is, of course, to fly the aircraft out of the impending storm area, provided you have sufficient warning time. The next best protective measure is to secure the aircraft in a storm-proof hangar or other suitable shelter. The remaining alternative is to ensure that the aircraft is tied down securely. Do not depend on the aircraft's weight to protect it from wind damage; sudden and severe gusts, particularly associated with willy-willies, can destroy a parked aircraft in seconds.

Advance planning

Always be prepared for the worst conceivable storm conditions: pouring rain, gusty winds exceeding 30 knots and no hangar facilities available. With such conditions in mind, aircraft owners and operators should plan in advance by learning their aircraft manufacturer's recommendations for tying down, location and/or installation of tie-down rings for attachment of ropes, special instructions for securing nosewheel type aircraft and tailwheel type aircraft, charts and graphs denoting aircraft weights and relative wind velocities that would make varied tie-down procedures necessary for pending weather emergencies, correct fitment of control gust locks and covers, and the correct angles for ropes and chains relative to the aircraft. This information is given briefly in the Pilots Operating Handbook or Aircraft Owners Manual, and in greater detail in the Manufacturer's Service Manual.

If an intended flight includes a landing away from base, and the aircraft will be left unattended for even a short time, a tie-down kit should be taken. This kit should include adequate stakes, ropes, fittings, a large hammer, control locks, chocks and covers for all external openings.

Tie-down considerations

Ideally, an aircraft should be parked in an area equipped with three point tie-downs, and should be tied down at the end of each flight to preclude damage from sudden weather changes. The direction in which the aircraft is tied down will ultimately be determined by the location of the parking area and mooring points; however, whenever possible, the aircraft should be parked nose-into-wind regardless of whether it is nosewheel or tailwheel equipped.

Tail into wind is not a desirable situation for any aircraft as they are not stressed to take strong winds from the rear. The reasons offered for tail into wind tie-down arise from stories of aeroplanes 'flying' on the tie-down ropes; however, if the aircraft is properly secured it cannot 'fly' on the ropes. The use of temporary spoilers on the wings, as discussed later, will reduce any tendency to fly and also reduce the loads on the tie-down system.

Tie-down facilities

Tie-down anchors for single-engine aircraft should provide a minimum holding strength of approximately 1350 kg (3000 lb) each; for multi-engine aircraft this should be increased to 1800 kg (4000 lb). The type of anchor in use varies, depending upon the type of parking area surface. Owners and operators who wish to obtain more information on the type of tie-down anchors available should contact the Airports Engineering Section at their regional Department of Transport office.

Wooden stakes driven into the ground are not dependable and will invariably pull out when the ground becomes soaked from the heavy rain which accompanies storms. Metal 'star' pickets are much better because they can be driven deeper and will hold firmer as they do not break up the soil. They should be driven in with a heavy hammer so that the angle between the picket and the tie-down rope is about 90 degrees. 'Screw' pickets, although not common, are probably the most secure of all and do not need a sledge hammer to secure them in the ground.

Tie-down ropes should be capable of resisting a pull of approximately 1350 kg (3000 lb). Ropes suitable for use fall into two classes: manila (or sisal) ropes and synthetic fibre ropes. These two groups have entirely different properties and should be used accordingly.

As manila ropes are a vegetable fibre they are susceptible to rotting and attack by fungus, and will perish when affected by oil and grease. Their strength deteriorates with age and they should be inspected regularly. The main objection to manila ropes is that they shrink when wet. The reason is simply that the individual fibres swell out and shorten when they absorb moisture. When the rope dries out, the fibres return to their normal size. This characteristic makes it difficult to undo knots after the rope has become wet.

Synthetic fibre ropes are not affected by oil or moisture and are reasonably stable in regard to their length, although they may stretch slightly when hot. Even so, they are preferable to manila ropes. The problem with synthetic ropes is the tendency for knots to loosen and slip. Extra care is required and knots that do not slip should be used.

Remember that no matter how strong the tie-down rope, it is only as good as the knot being used. Make a study of the types and applications of simple knots and practise tying them in the comfort of your home; do not wait until the storm hits.

Securing the aircraft

Tie only at the proper tie-down rings. Never tie to a strut as the rope may slip and result in bending of the strut.

Synthetic ropes are tied without slack but also without strain on the aircraft. If using dry manila rope allow about 25mm (one inch) slack to allow shortening of the rope if it absorbs rain or dew. Wet manila ropes may be treated as synthetic rope but remember that the knot may slip after the rope has dried.

Too much slack will allow the aircraft to jerk against the ropes, possibly loosening the tie-down and resulting in damage to the aircraft structure. Too much strain can place inverted flight loads on the aircraft, greater than it is designed to take.

Wing ropes should be tied so that they splay forward and outward about 45 degrees to the ground and the nose/tail ropes should be in the fore and aft line of the aeroplane. The nose and tail can have two ropes each, both splayed outward from the aircraft centre line. If the ropes are knotted correctly, with the correct tension, the aircraft is secure. At aerodromes where parallel tie-down cables are installed, the ropes are tied vertically to the cables, without slack.

All flight controls should be secured to prevent them banging against the stops. Some aircraft are equipped with integral gust locks operable from the cockpit. Others require the use of externally fitted, padded control chocks. Some manufacturers recommend securing the control column by use of the pilot's seat belt, while others provide control locks fitted inside the cockpit.

When using external chocks, covers and plugs, ensure that red streamers are fitted to alert future users of the aircraft. Ailerons and rudders should be secured in their neutral position, as should the elevator on nosewheel aircraft. Flaps should always be 'up'. Tailwheel aircraft should have their elevators secured in the full 'up' position. If it is absolutely unavoidable that a tailwheel aircraft has to be tied down tail into wind, the elevator should be in the full 'down' position.

Chocks should be placed fore and aft of each wheel and secured by ropes or by nailing cleats from one chock to the other. Housebricks and pieces of 'four by two' are poor excuses for chocks. Many light aircraft are equipped with collapsible chocks made from light weight metal. As these chocks may be dislodged in a strong wind or by the slipstream from other aircraft, they should be secured by ropes on either side of each wheel.

Spoilers can be made from long sandbags about 50–75 mm in diameter (Grandma's door draft excluders are ideal). They should be placed at the 25 per cent chord line along the full span and secured against movement. An alternative spoiler can be manufactured from a length of 50 x 50 mm timber with a strip of foam rubber glued along one side to protect the wing surface. The spoiler is placed on the top of the wing and secured by ropes or rubber bungees. Pieces of cloth or carpet should be used to protect leading and trailing edges against chafing by the ties.

When securing an aircraft, it is good practice to fasten all doors and windows properly, to minimise damage inside the aeroplane. Both exhaust and intake openings for reciprocating and turbine engines should be covered to prevent entry of foreign matter. Pitot-static vents and tubes should also be covered to prevent damage.

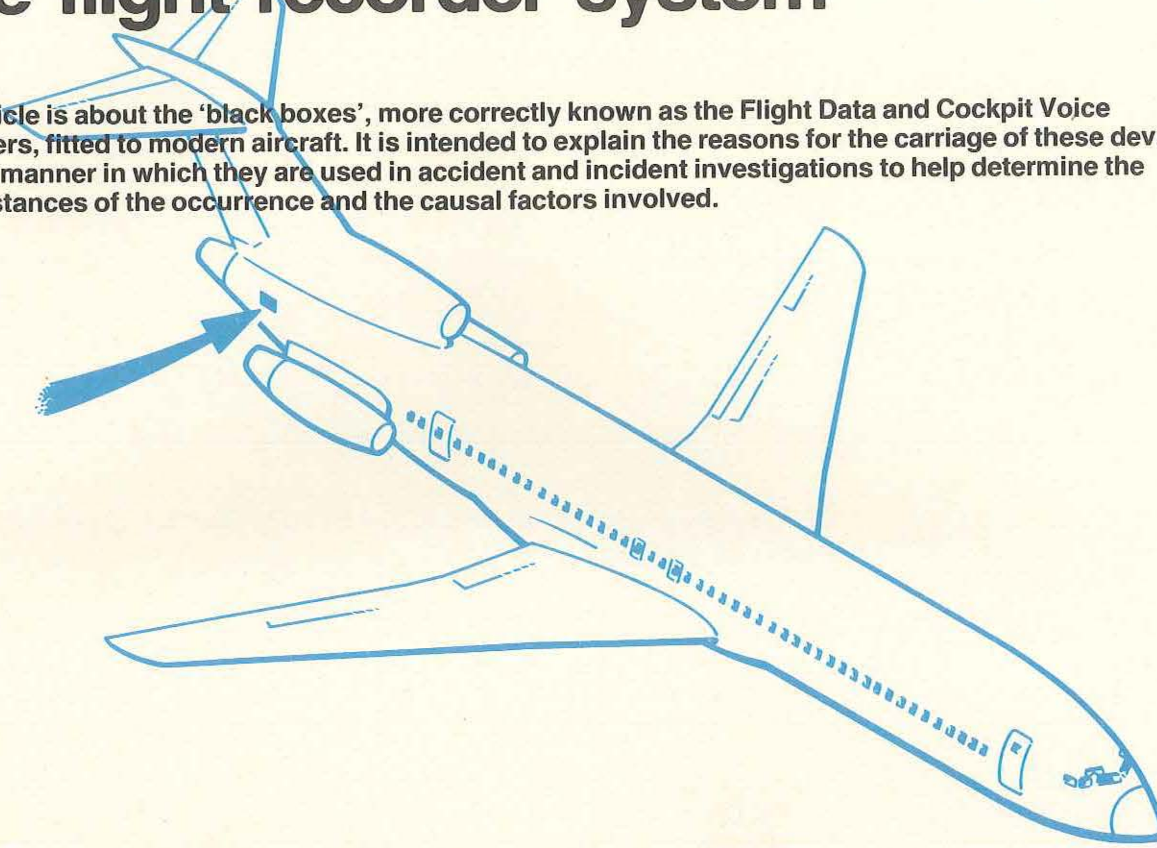
Always secure the aircraft by ensuring doors and windows are locked; leave the keys with some responsible person.

Become familiar with local weather patterns and monitor weather reports for high wind warnings, thunderstorms or other potential hazards. Learn the correct tie-down procedures for your aircraft and remember that aircraft parked outside, in the open, should always be tied down

In order to obtain a positive illustration for the points made in this article, staff of the Digest went to Moorabbin Airport to photograph a properly secured aircraft. They were not able to locate such an example, but were able to borrow wheel chocks and a pitot cover to add to the aircraft illustrated above which was well tied down. Although this aircraft provided the most suitable subject, the elevator trim tab had not been set in the neutral position. To satisfy the manufacturer's recommendations it should also have had the cowl flaps closed, a surface control lock installed over the fin and rudder, and a tie-down rope securing the nose gear torque link. It was also noted that wheel spats preclude the use of wheel chocks of an effective size. ●

The flight recorder system

This article is about the 'black boxes', more correctly known as the Flight Data and Cockpit Voice Recorders, fitted to modern aircraft. It is intended to explain the reasons for the carriage of these devices and the manner in which they are used in accident and incident investigations to help determine the circumstances of the occurrence and the causal factors involved.

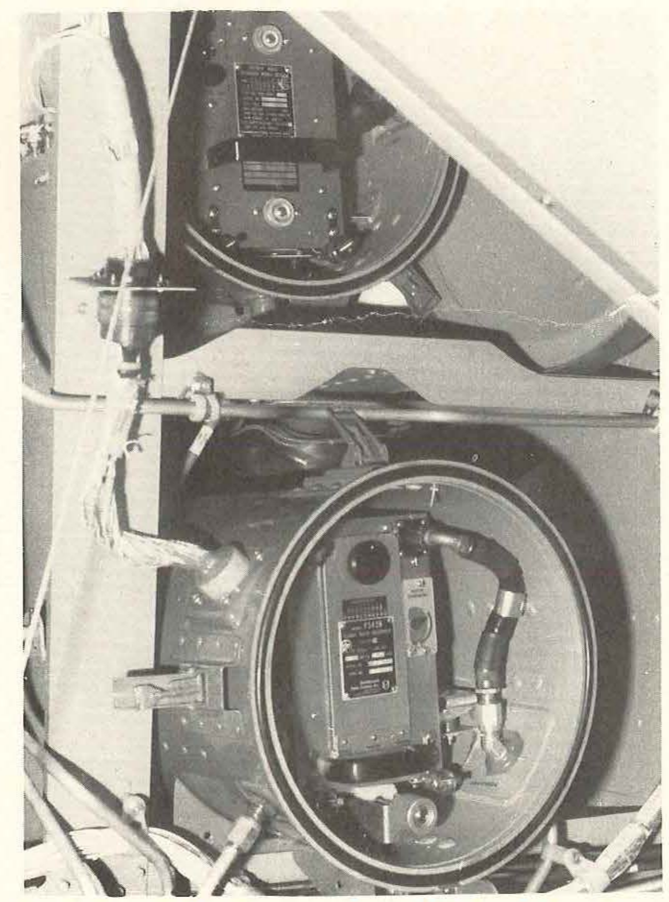


When an airline aircraft is involved in an accident, the news media often refer to a search being conducted to recover the flight recorder 'black boxes'. To many of their readers this term has some mystical connotation but it is only a name given to many items of equipment fitted to aircraft, particularly those of complicated mechanical or electronic design which require specialist understanding.

Radio and electronic equipment racks in modern aircraft are filled with black boxes most of which, in fact, are painted black. Flight recorders are also in boxes, of a similar size to many other items of aircraft equipment, but they are painted red or orange, not black. This is to make them more conspicuous amongst the wreckage of a major aircraft accident. The recorder boxes are also of special construction to protect the recorder from high impact forces, intense fire or a corrosive environment. In addition, some recorders are fitted with underwater location devices and reflective tape to assist in their recovery.

That such precautions are necessary indicates the importance of flight recorders in an aircraft accident investigation. Modern aircraft are becoming more complex, and flying higher and faster than before. They are also much safer, but on those infrequent occasions when there is an accident, the damage to the aircraft can be so great that normal means of investigative examination are made extremely difficult.

Another development that is making flight recorders even more essential is the increasing use of cockpit instruments with various forms of electrical presentation. In the event of an accident, and the resultant loss of electrical power, all evidence of instrument readings can be irretrievably lost — unless retained on a flight recorder.



The FDR and CVR as fitted to the Boeing 727 aircraft, shown in their protective containers with the covers removed. They are located in the rear fuselage of the aircraft as indicated in the diagram above.

Flight recorders

There are actually two separate and distinctly different recorders which can be fitted to an aircraft. These are the flight data recorder (FDR) and the cockpit voice recorder (CVR). The FDR is designed to record information concerning the aircraft's flight path. The CVR, perhaps better described as the cockpit 'audio' recorder, provides a record of all sounds in the cockpit area. This, of course, includes flight crew statements, both on intercom and over the radio but, of equal importance, also encompasses such sounds as warning alarms, equipment and engine operating noises, and even the background airflow.

Together, the two recorders provide a wealth of information that might not be available from any other source. This data not only assists accident investigators to establish *what* happened but, more importantly, *why* it happened.

In Australia, it is a requirement that both types of flight recorder be fitted to all aircraft over 5700 kg maximum take-off weight which are turbine powered or were first certified after 1 July 1965. This covers most regular public transport aircraft, the sophisticated executive jets and even the larger turbine-powered helicopters.

Flight data recorders

There are several types of FDR available but only two are common in Australia. The earlier models, which are fitted to the majority of aircraft, record altitude, airspeed, magnetic heading and vertical acceleration against a time base. Operation of a microphone transmission switch is also generally recorded, to permit accurate synchronisation between the FDR, the CVR and any ground-based communication recording facilities.

The information is engraved on a 12.5 cm wide roll of stainless steel foil as it moves from a supply spool, across a recording head, to a take-up spool. This operation is similar to the movement of a film in a camera, except that instead of a picture the result is a series of grooves cut into the foil. The foil runs for 200 hours of aircraft operation and then can be reversed to engrave on the other side. The photograph of a typical FDR tape indicates why this type of equipment is generally referred to as a 'scratch' recorder.

In the event of an accident the recorder foil is placed on a special readout machine and held flat under a sheet of glass. The position of each scratch is measured using an electrically positioned microscope and the information fed into either an electric typewriter or a digital computer. After correction for variables, such as calibration figures, the data is presented in diagrammatic form, portraying the aircraft flight path prior to the accident. Much of this work, such as positioning the microscope and the preparation of diagrams, must be done manually and hence readout of this type of recorder is a slow, laborious task.

The second type of FDR is fitted to the later generation of aircraft, for example Boeing 747s. The information is recorded on a magnetic tape, similar to that used on hi-fi reel-to-reel recorders, only in a continuous loop of some 25 hours duration. These newer recorders, known as digital flight data recorders (DFDR), represent a significant advance in terms of the amount of information available to accident investigators. Australian aircraft with this equipment are required to record a minimum of 20 parameters. These include the five previously mentioned for scratch recorders, plus certain engine parameters, aircraft configuration, control angles, pitch and roll attitude, longitudinal acceleration, etc. Each of these parameters is recorded at least once every four seconds, but some information which can change very rapidly, such as vertical acceleration, is recorded as frequently as eight times per second.

DFDR equipment is capable of recording much more than the required 20 parameters. Hence, many operators voluntarily wire other aircraft components and systems into the DFDR.

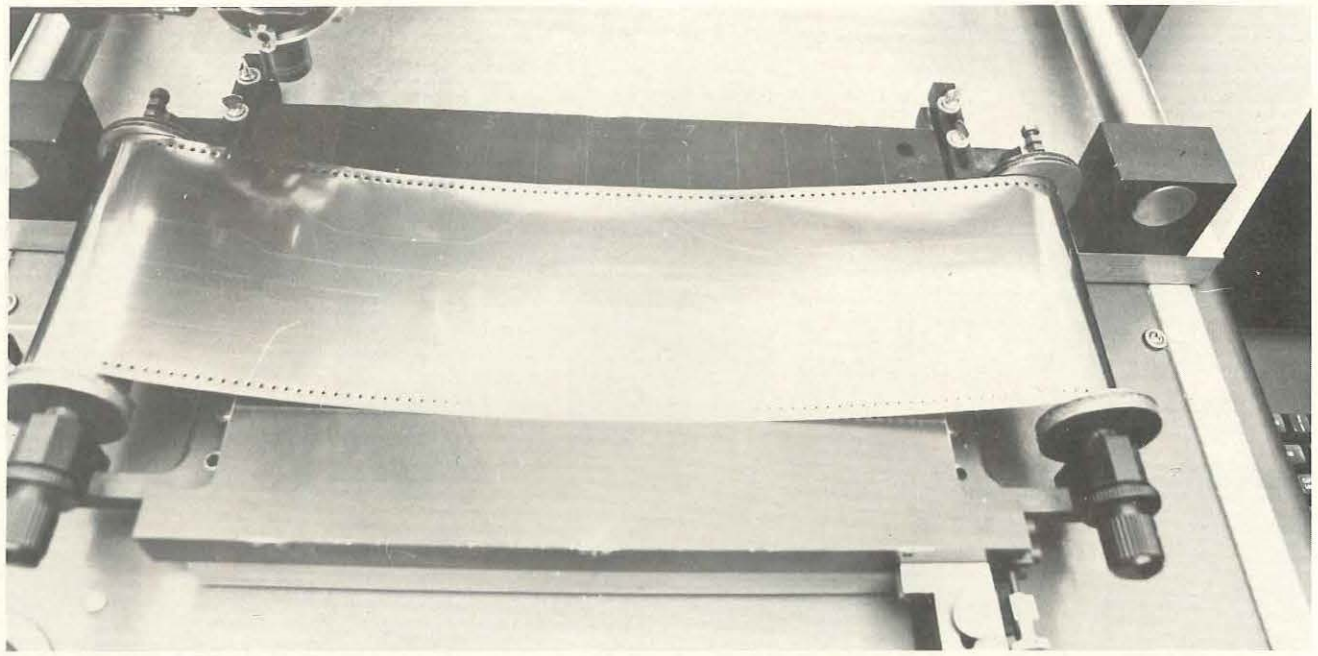
Readout of a DFDR tape is relatively simple and quick, as it is largely an automated process. If the equipment is recovered intact it can be connected to the readout station and its associated computer. If, on the other hand, the recorder is damaged, the protected magnetic tape can be removed and played back on reel-to-reel equipment. It is then only necessary to program the computer to be aware of those particular parameters recorded by the individual aircraft operator, and the readout can proceed. Within a few hours the accident investigation team can be provided with a printout of tabulated data. In many cases this results in early elimination of those aircraft systems that were functioning normally and enables the team's efforts to be concentrated on the systems which show abnormal indications. Later in the investigation it is common to convert the tabulated data to graphical form for easier understanding.

Cockpit voice recorders

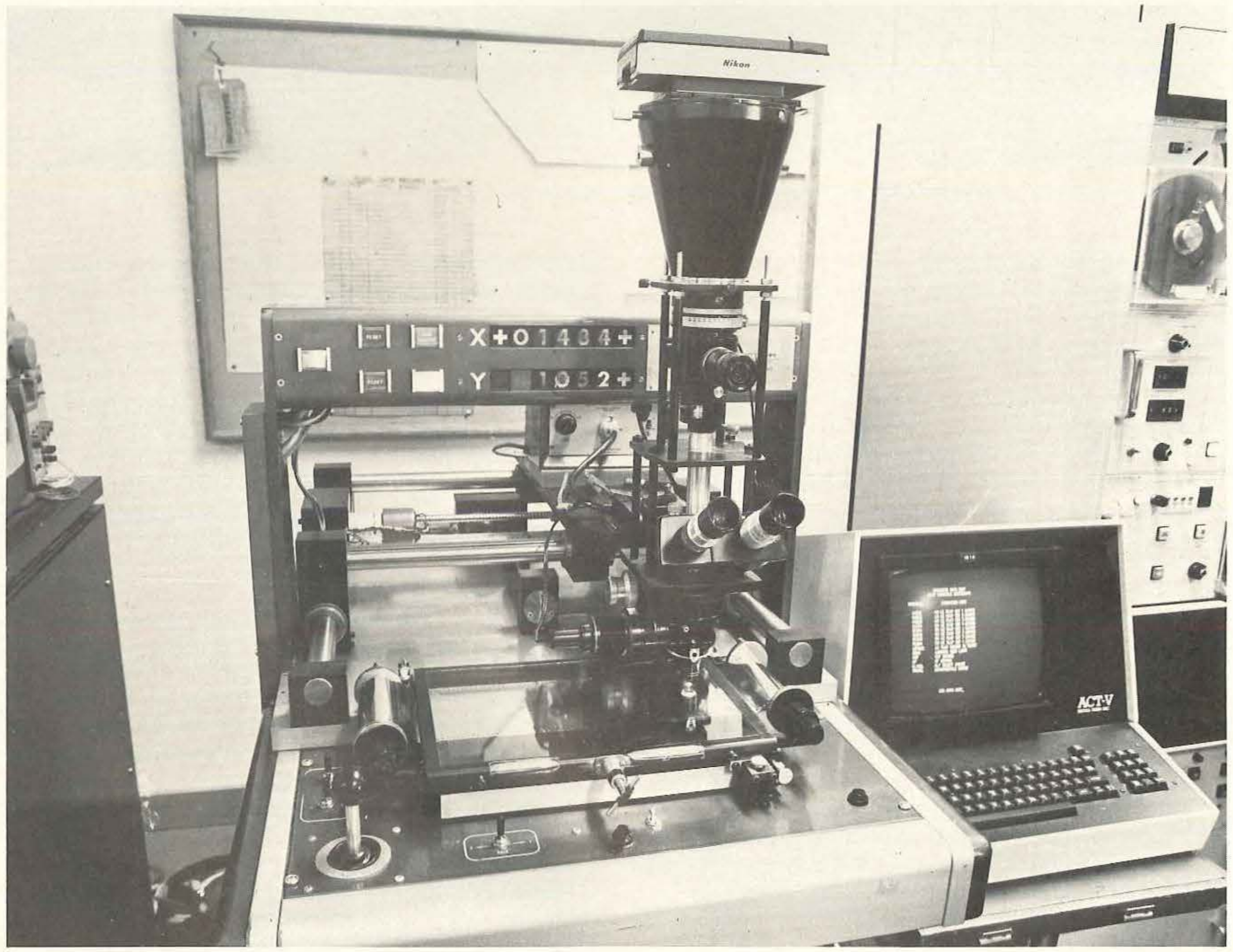
The CVR is a four channel tape recorder, generally using a continuous 30 minute loop of magnetic tape. Normally, three of these channels are connected directly into the captain's, first officer's and flight engineer's communication panels, whilst the fourth channel is connected to an open microphone on the centre or overhead instrument panel. Although the playback equipment appears different from domestic tape decks it operates in much the same way. However, to gain maximum benefit from audio records it is necessary to have additional equipment so that the CVR output can be filtered and/or modulated to improve upon the original recording. Other facilities, such as variable speed, repetitive replay and spectrum analysis equipment, are also used to clarify distorted sounds and analyse the sources of various noises.

Use of data recorders

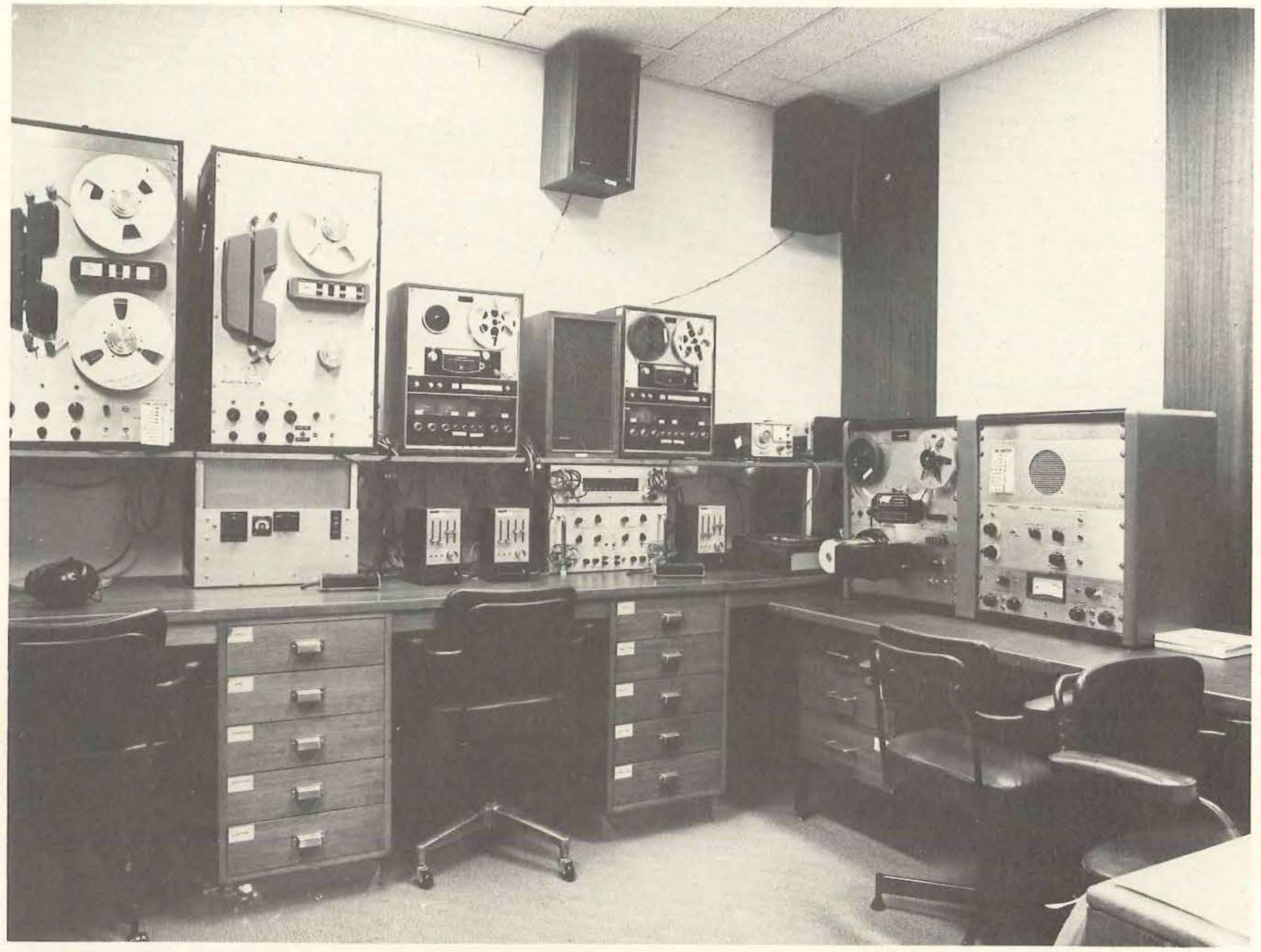
The development of detailed and accurate flight recorders, particularly the DFDR, has greatly simplified the accident investigation team's job of reconstructing and analysing the events leading up to the accident. One way in which this is done involves the use of aircraft simulators. A simulator computer, of the appropriate aircraft type, can be programmed with the information obtained from a flight recorder system to play back the accident flight. Not only does this help establish what happened in the accident, but also permits experiments to be carried out to find the best way to prevent another accident, should the same circumstances occur again.



The stainless steel tape from a 'scratch' recorder showing the series of grooves cut in the foil.



The FDR readout machine showing the recorder foil in place under the glass sheet.



Audio equipment used to read out CVR and Airways Operations tape recordings.

If an accident happened at night, or over mountains, a desert, a swamp or the sea, the flight recorders might be the only means of establishing what happened. At the very least, the recorders save an investigation team many days, or weeks, of delay as they examine the wreckage in an attempt to establish the sequence of events. As a guide to the time and effort involved in wreckage examination, a recent light aircraft accident in Australia required four weeks for a three man investigation team to complete the wreckage examination, establish a sequence of events, and isolate the probable cause of the accident. Such an exercise with an aircraft of the size and complexity of a wide-bodied jet would be vastly more difficult.

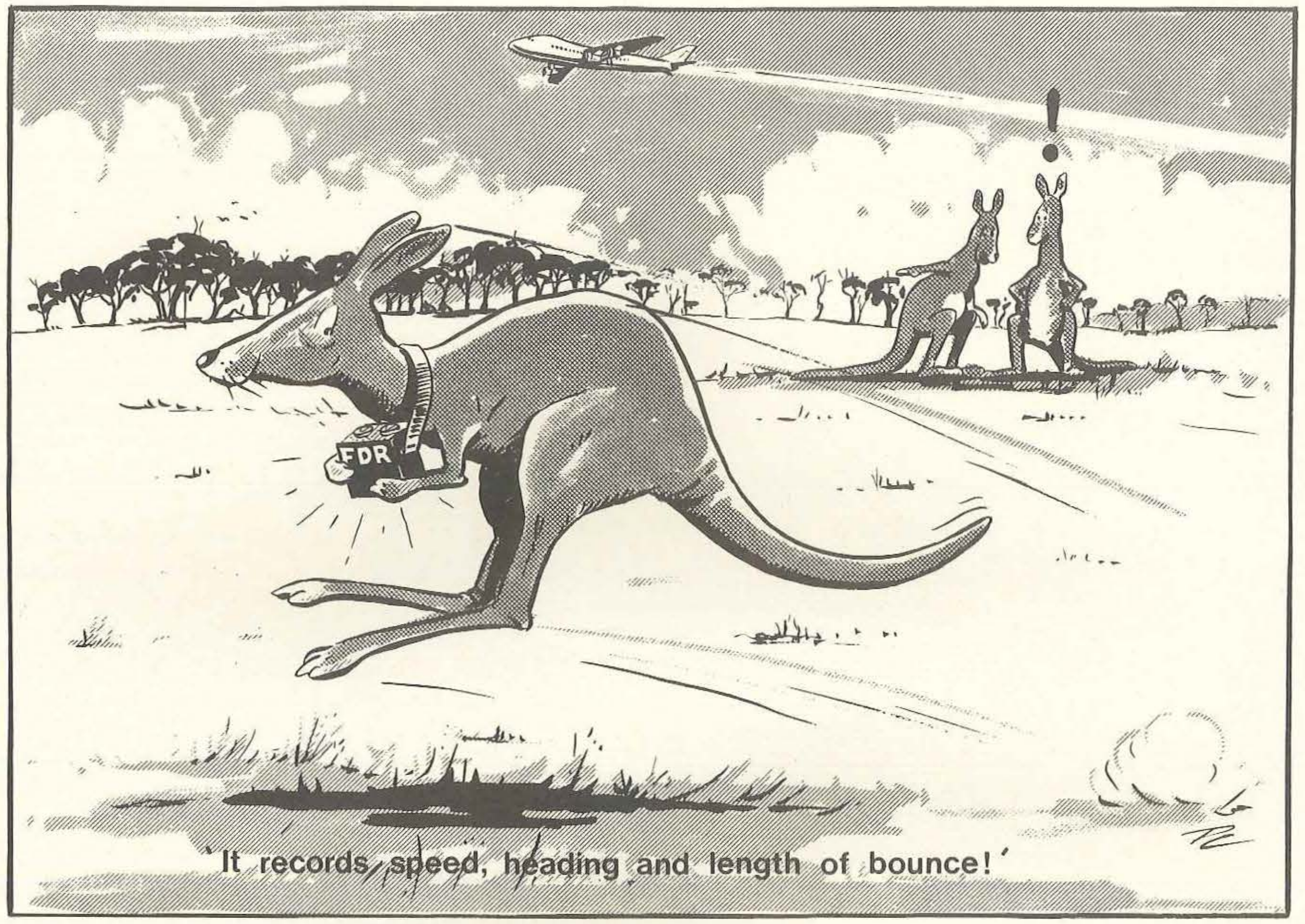
Flight recorders have solved many 'mystery' accidents. On the other hand, there have been many accidents involving aircraft not equipped with flight recorders in which, despite every possible effort, the cause still remains unknown. In one overseas accident an aircraft crashed into the sea and very little of the wreckage was recovered. However, the CVR was found and this record alone was sufficient to establish that the aircraft engines had not failed — as was generally expected — but rather the accident resulted from a flight control malfunction.

The flight recorders are, of course, particularly valuable when the evidence is nebulous or transitory. Possibly the best example of this is the great increase in awareness of wind shear problems in recent years. Prior to the development of flight recorders, the part played by the wind in many aircraft accidents was probably underestimated. Thanks to flight recorders the sudden effects upon an aircraft flight path resulting from wind shear can be established. Also, in the United States, the information obtained from flight recorders is being programmed into simulator computers to permit an evaluation of pilot and aircraft response to wind shear on approach. Research and development of both equipment and techniques, firstly to detect and then to counter problems such as wind shear, is still in progress.

Australian facilities

The Air Safety Investigation Branch of the Department of Transport has FDR and CVR laboratories which are equipped to read out all types of recorders fitted to Australian-registered aircraft and many of the recorders fitted to foreign-registered aircraft. Accident prevention is an international endeavour and, in support of the International Civil Aviation Organisation recommendations, Australia provides a readout facility for a number of our South East Asian neighbours.

Flight recorders will play an increasingly important role in air safety as improved methods are developed for the analysis and interpretation of the recorded information. In turn, this will provide the basis for more effective accident prevention and safety education, thus aiding the whole aviation community in its endeavours to improve safety in the air. ●



In brief

A variation on Murphy's Law:
If there is a possibility of several things going wrong, the one that will go wrong is the one that will do the most damage!

Because of a flat aircraft battery, the owner of a Cessna 206 decided to use a spare battery and jumper leads to start the aircraft's engine, and then run the engine to recharge the installed battery. He positioned the spare battery on the ground just forward of the left mainwheel, connected it to the aircraft battery, but then decided to refuel the aircraft before he attempted to start the engine. The jumper leads were disconnected from the aircraft and were left lying on the ground, still connected to the spare battery.

The owner brought some 200 litre drums of Avgas to the aircraft and commenced refuelling the left tank. The refuelling equipment consisted of a double action hand pump and a plastic hose. The hose had no nozzle, and there were no metal fittings on the end of the hose. It was not bonded and no earthing straps were used. After placing the end of the plastic hose some 15 centimetres into the tank, the owner climbed down from the wing and began to pump the fuel. The vibration of the pump caused the hose to come out of the fuel tank and fall to the ground. It fell on to either the battery or the jumper lead terminals. A static discharge from the plastic hose or a short between the terminals provided a spark and ignited the spilt Avgas.

A large fire immediately broke out around the nosewheel of the aircraft. The owner went to obtain fire fighting equipment and assistance, but on his return only two or three minutes later the fire was too intense to be approached. As the fire progressed an unopened 200 litre drum of fuel beneath the right wing of the aircraft exploded. The aircraft was destroyed.

In the past there have been many examples of problems caused by undesirable haste in dealing with inflight emergencies. On other occasions pilots have dealt successfully with the inflight emergency, but have then caused further problems by not complying with standard procedures in their efforts to return to earth as soon as possible.

This article relates the planning, co-operation and effective use of all available resources which prevented landing gear damage on an aircraft from causing a major accident. It is reprinted from the February 1980 issue of *The MAC Flyer.*

Although our goal is usually a smooth landing, this crew found themselves faced with the problem of . . .

How to plan a crash landing

(Photographs courtesy of the Christchurch Star)

"Not an experience I would recommend." That's how Captain Robert E. Colley described to reporters his crew's dramatic "planned" crash landing of a C-141 Starlifter at Christchurch, New Zealand. Departing Christchurch on 29 October 1979 for a round trip to Williams Field, McMurdo Station, Antarctica, the 349th Military Airlift Wing (Associate) crew's flight to the frozen continent was routine until their landing on grid runway 26. During the roll out they experienced an extra rough ride on the snow-covered ice runway. Post flight inspection of the 141 revealed a shattered taxi light and a broken brake line. With no en route maintenance available, the crew capped the line and refilled the number three hydraulic system.

Less than two hours later, 41 000 kilograms of fuel and 12 passengers were aboard for the return flight to New Zealand. With Captain Colley in the left seat and Major John W. Hartzell flying as copilot, the Starlifter started its take-off at 0615 hours GMT. Just as Captain Colley barked, "Gear up," the copilot noticed an unsafe indication for the right main gear, and did not raise the handle. At nearly the same time McMurdo Ice Tower called, "MAC 249, you lost your starboard wheels. They're hanging."

Captain Colley levelled the Starlifter at 3000 feet and kept the speed below 235 knots. He then transferred aircraft control to Major Hartzell and asked the scanner, MSgt Stephen E. Reynolds, to check the gear. A check by Ice Tower confirmed that the right main gear was positioned lower than normal, and the controller speculated that it was "hanging by hydraulic lines". From inside the Starlifter, Sergeant Reynolds could not see inside the gear well because of ice on the inspection window.

Meanwhile the navigators, Lt Col Frank J. Jackson and Captain Lance W. Bachran, busily calculated their chances of getting to New Zealand. Without fuel consumption charts available for gear down cruise, it was impossible to determine for certain if MAC 249 could make landfall in Southern New Zealand. One option which seemed the most reasonable however, was that they could cruise northward for about two hours, see how things were going, and still be able to return to McMurdo if need be. Based on this, and the generally inhospitable conditions in Antarctica, Captain Colley decided to continue on course for their original destination. He directed Major Hartzell to start a climb at 235 knots, the gear limiting speed.

At FL 200, 235 knots equalled .55 Mach, so the Starlifter was cruising as fast as it could within technical order limits. With the copilot controlling the C-141, Captain Colley worked the HF radio to get more information on how to best handle the malfunction. Because of their remote location, he was unable to set up a normal Conference Skyhook with the 22nd Air Force. Fortunately, another Starlifter, MAC 59403, had departed McMurdo two hours earlier and that crew was in contact with the MAC Operating Location at Christchurch. Aboard MAC 403, Major Peter J. Ruppert, 60 MAW Standards and Evaluation, offered to relay messages for 249.

The crew's most pressing problem was ensuring that the fuel in their C-141's tanks would provide enough endurance for a landfall and a safe touchdown in New Zealand. Extra drag from the extended wheels was increasing fuel consumption significantly above the normal cruise fuel flow. After conferring with Major Ruppert and the experts assembled at Christchurch, Captain Colley decided to retract the functioning landing gear.

Working the engineer's panel, MSgt Alexander Schneider prepared to depressurise the aircraft so that the main gear could be pinned and electrically disconnected from the gear system. In the cargo compartment, TSgt William R. Friedrich, loadmaster, discussed the emergency with the passengers and helped them don oxygen masks. With the crew and passengers on oxygen, the cabin was depressurised, the scanner pinned the gear and then cabin pressure was restored. Finally, the left and nose landing gear were retracted.

Even with this decrease in drag, the fuel flow remained high, and after consultation with the experts in MAC 403 and at Christchurch, it became obvious that 249 would have to climb to make it to New Zealand. Because of the decreasing air density, this option required increasing the Mach number and thereby exceeding normal operating limits. Experimenting with the Starlifter, Captain Colley found that the crippled aircraft began to buffet at speeds above .63 Mach. Therefore, the copilot kept the speed below .62 during the climb to FL 300. This action, coupled with a favourable wind shift, assured them of at least reaching one of the two airfields in Southern New Zealand — Dunedin or Invercargill.

As the plane consumed fuel, they were able to climb higher and eventually reach FL 350. Better engine efficiency at the higher altitudes assured landing somewhere in New Zealand, and recovery at Christchurch became a possibility. The original flight had called for five hours flying to their destination, but because of their decreased speed, the mission would stretch to over seven hours.

While the right-seater handled the aircraft, the pilot-in-command, the crew, and experts on the ground began planning for the upcoming landing. As time passed, they reviewed several checklists and Dash One (Flight manual) discussions that seemed appropriate to their situation. Ahead at Christchurch, MAC people were in contact with the 22nd Air Force Standards and Evaluation and Lockheed, the Starlifter's manufacturer, who provided expert advice and detailed technical information. Together, the ground-bound advisors compiled a list of things for MAC 249's crew to consider before landing.

Captain Colley's initial plan was to land with the nose gear down and pinned, and the left main gear up, because he believed the right gear truck would separate from the plane upon touchdown. Generally, this seemed to be a way to keep the Starlifter on the runway and give the crew and passengers the best chance for survival. Next he made sure every crew member understood the plan of action for the upcoming night approach and emergency landing. In the pilot's words, "We made plans but still tried to be flexible and open to suggestions . . . (then) we rehearsed it."

About 500 miles out, the fuel status gave the crew enough confidence to try for a landing at Christchurch. "(At this point) we had no doubt that we could make landfall in New Zealand," recalled Captain Colley, "but when we turned for Christchurch . . . we were committed."

"The radios hadn't been quiet for five minutes," the Captain remembered, and about 150 miles out he finished his consultations on HF and took control of the aircraft for descent and landing. As the Starlifter descended below 10 000 feet, the engineer depressurised the aircraft. For the first time, Sergeant Reynolds was able to remove the gear pod access panel and take a good look at the damaged bogey. He saw the gear truck was still attached to the 141 by the scissors assembly, and the crew estimated that the gear might stay with the aeroplane for part of the landing roll.

Now aware of the right gear's true condition, the crew and the experts on the ground re-evaluated their plans. They decided that landing with all the wheels down might be the best course of action. Also, the crew would pin the nose gear down so that the left main could be retracted if necessary to keep directional control after touchdown.

Air Traffic Control vectored the Starlifter for an ILS approach to Runway 20 at Christchurch. Gear extension was delayed until they were on base leg to further conserve fuel. As the 141 let down through the dark mist above the Waimakariri River on the ILS glideslope, Captain Colley spotted the approach lights at two and a half miles out. The dangling right gear touched the runway first, and a few seconds later the Captain set the Starlifter's weight on the left main and nose gears. Captain Colley held left aileron in to keep weight off the damaged right gear. As the aircraft slowed, the right main gear truck, which was laying on its side, became trapped under the gear pod and helped for a while to support the aircraft's weight. The copilot shut down the outboard engines as planned, and when the Starlifter's speed reached about 50 knots, the right main gear truck finally separated. The big airlifter smoothly settled on to the number four engine and the right wing tip. Although it veered to the right before grinding to a halt with 4000 feet of runway remaining, MAC 249 stayed on the pavement. In the 50 emergency vehicles that had responded, crash crews watched a momentary rooster tail of sparks fly clear above the Starlifter's T-tail as the right outboard engine and wing tip skidded along the ground.

After the C-141 stopped, Sergeant Reynolds opened the crew entrance door and assisted the passengers and other crew members in departing the aircraft. Captain Colley and Major Hartzell were the last to leave the flight deck and checked the cargo compartment for possible stragglers before they abandoned the crippled C-141. Fire department vehicles were at the scene in seconds and started pouring water and foam on the number four engine, right wing, and along the side of the fuselage. Fortunately, there was no fire.

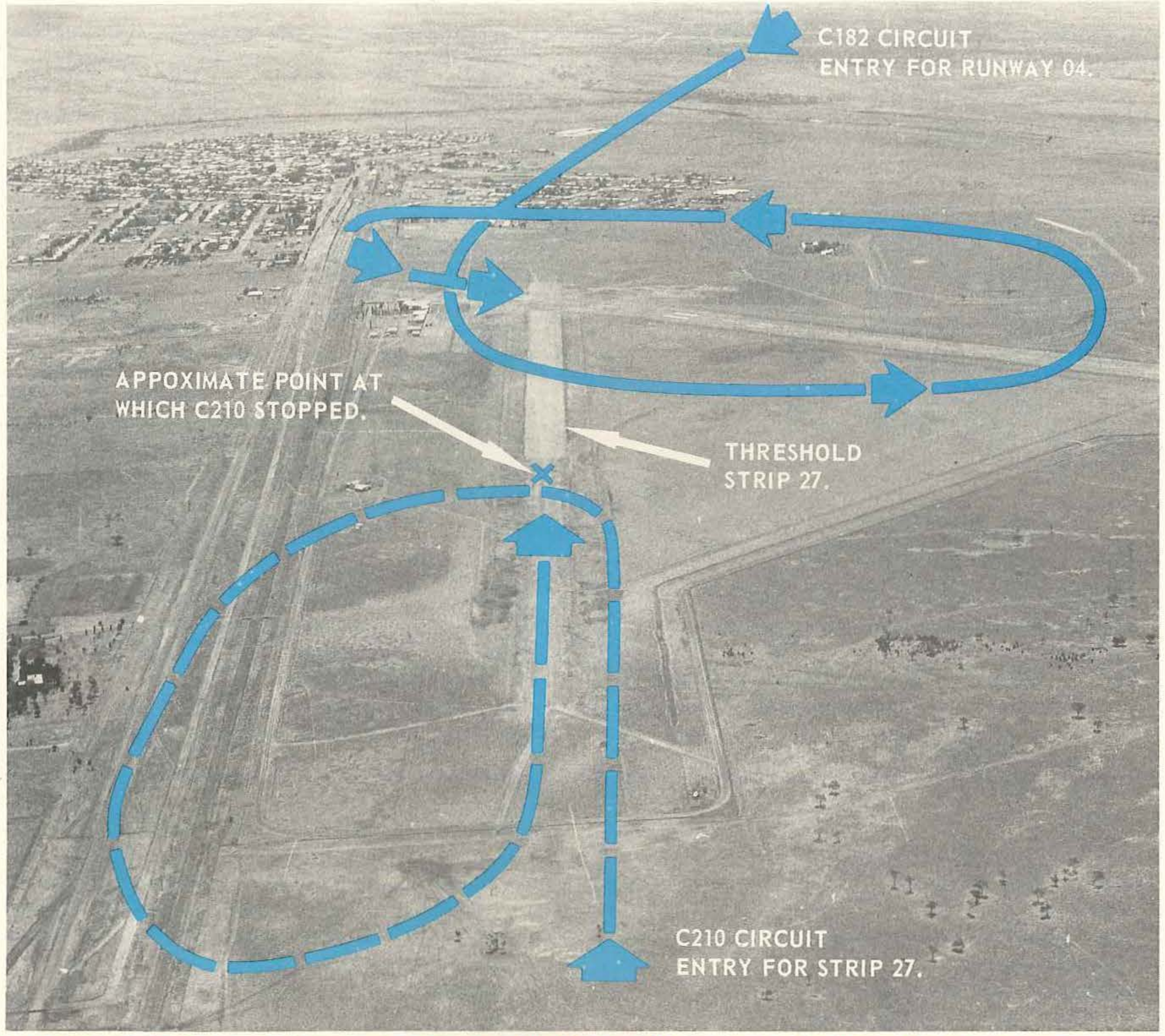
Captain Colley and his crew had worked their way through an extremely serious emergency situation. They were successful for many reasons: their own expertise, the aircraft commander's leadership, the availability of experts on the ground to help, and the advice and co-operation of the crew of MAC 403. Some might contend a bit of luck was also a factor. But isn't luck, after all, just the crossroads where opportunity and preparation meet? ●

Unnecessary distraction — wheels up landing

The chief pilot of a country based charter company had developed a standard procedure of flying straight in approaches in his operations wherever possible. Subject to familiarity with the destination, prevailing conditions and traffic, he would use the strip or runway aligned closest to his inbound track. He considered himself very familiar with the aircraft and used this procedure irrespective of wind direction, unless a downwind was too strong for a short strip.The sole reason for these operations was to save time. In disregarding the regulations relating to operations from aerodromes, the pilot chose to ignore procedures which have been developed for the safe and efficient use of facilities by aircraft operators.

On this occasion the pilot was returning to base in a Cessna 210 from a charter flight to a town about 180 kilometres east of the base. The east-west strip at the base had been shortened by 720 metres to 1066 metres a few years before. It was the pilot's habit to touch down on the disused portion of the strip when landing into the west, especially when operating with a downwind or crosswind, to allow a longer landing run and thus reduce brake wear. The Flight Service Unit passed the wind velocity as 'zero one zero degrees, one zero knots', but the pilot read the direction as one zero zero degrees. He intended to land straight in on the 27 strip, even though he expected a 10 knot downwind.

At top of descent from 6500 feet, the pilot was given traffic on a Cessna 182 inbound from the north west and estimating the circuit area about two minutes before him. He now decided to delay his final choice of landing direction until in the circuit with the other aircraft in sight. In the circuit area the Cessna 182 pilot reported overflying for the 09 strip, but shortly after advised changing to runway 04.



View of the aerodrome facing west, showing the approximate flight paths of the two aircraft during the circuit entry and approach to land.

Meanwhile the Cessna 210 had entered the circuit and was flying an abbreviated pattern for the 27 strip. He had in fact not flown over the field, but had turned crosswind prior to reaching the 27 threshold. This meant that he turned away from the other traffic, and although he requested the other's position twice, and was looking for the aircraft throughout the circuit, he still had not sighted it by the time he touched down. He failed to hear a taxying call from the aircraft some two minutes prior to his landing.

The end result of this continuous distraction was that the Cessna 210 landed with wheels up on the disused section of the 27 strip, over 380 metres short of the threshold.

The pilot did not use a printed checklist, but had committed downwind and final checks to memory. The first item of the downwind check was to extend the landing gear and make the first selection of flap. The last item was to check the landing gear extended green light and visually confirm the extension of the left main gear. His prelanding check on final would also include the green light. On this occasion the pilot considered that he had fully completed all the checks. In fact he had gone through the lists mentally without physically doing or checking some of the items. He realised on final that he had not extended any flap at the normal downwind position, but did not realise that he had also omitted to extend the landing gear.

Thus the pilot's complacency and over-familiarity with the aircraft and his company's operating procedures combined with his unorthodox practices created unnecessary difficulties for him which led to the omission. A further example of the pilot's attitude to his responsibilities is that at the time of the accident his Commercial Pilot Licence had lapsed: the expiry date was over six weeks earlier.

This accident demonstrates the necessity of conforming to established procedures for the good of all members of the aviation industry. In an effort to save a few minutes, this operation cost a lot more than it could have gained. We can retrieve some value from the accident if we are prepared to learn from another's mistake. Bad habits do not just appear. They are allowed to develop ●

The Engine Doctor and density altitude

During the investigation of an aircraft accident which occurred in Central Australia in midsummer, the pilot revealed a distinct lack of knowledge on the subject of density altitude. At the time of the accident, 1700 hours local, the temperature was 39 degrees Celsius. With an aerodrome elevation of about 1700 feet AMSL, this resulted in a density altitude of nearly 5000 feet. The pilot was unaware of the possible effects of this on his aircraft performance and once again, as so often is heard, he had been told that 'leaning the mixture is not done below 5000 feet'.

To help you better understand the effects of density altitude on aircraft performance we present the third article in the Engine Doctor series, adapted from the U.S. Federal Aviation Administration magazine, *General Aviation News*.

Aircraft Owner: Doctor, I've just had a shattering experience in my aeroplane.

Doctor: Not literally, I hope.

Owner: Worse! I've been humiliated, in a public place. I don't know what I'm going to do. I may never fly again.

Doctor: I see. Well, that certainly seems to be a problem. Is there anything I can help you with?

Owner: There sure is. You can tell me what's wrong with the engine in that aeroplane of mine, which you certified just last month as being okay. It let me down when I needed it most. It had about as much power as a sick kitten.

Doctor: Well, I remember it looked pretty healthy to me. When did the problem develop?

Owner: My partner and I went to a density altitude seminar at one of the outback aero clubs and they were going to have this take-off contest on the next day, to see who could come closest to getting off in the distance they predicted. My partner introduced me around but then he got to saying that I was an ace pilot when it came to flying by numbers, and I was sure to win the take-off contest. He even offered to bet anyone in sight, and give them odds. There weren't any takers but I guess they were just being polite. You beginning to get the picture?

Doctor: I believe it's coming into focus. I will assume that you did not win. Where did you finish — second? Third? A bit further back?

Owner: All the way back. I was about fortieth in a field of 40.

Doctor: That is discouraging. What were the rules of this competition?

Owner: Well, they had Runway 19 set up with judges alongside the field and instruments so that they could tell how much distance from start it took you to clear a 50 foot obstacle. You were penalised for every extra metre you allowed yourself and disqualified if you didn't clear that imaginary barrier in the distance you predicted. They had one category for private pilots, and another for commercial, etc. Of course I had to go for broke.

Doctor: Of course. May I assume that you made all the necessary computations correctly?

Owner: You bet. At standard conditions my aircraft needs about 625 metres to get over a 50 foot obstacle, according to the book. Temperature was about 24 degrees Celsius at noon and the field elevation was 2300 feet. On the chart that added up to a 50 per cent increase in take-off distance, so I threw in a little for good measure and added 300 metres to the 625 — 925 was the number I put down. Actually I figured I could clear the obstacle in about 800, considering the way that powerplant was purring when I left home. I would have, too, if the engine hadn't let me down. Would you believe it, I was still straining to get airborne when we passed under the obstacle point?

Doctor: Hmmm. Anyone else have that problem?

Owner: Yeah, there were several other pilots I knew had a struggle, but no one overshot the mark as far as I did. According to the theodolite measurement, it took me 1260 metrés from starting roll to get up to 50 feet above the runway. If those judges hadn't been friends of my partner I would have been sure somebody was kidding. I was so humiliated I almost flew straight home after I got into the air.

Doctor: A painful experience, I'm sure, but also a learning experience.

Owner: What did I learn? Seemed to me I just had a weak engine — I could feel it was not running smoothly during the take-off.

Doctor: Did you have any trouble with the engine once you became airborne?

Owner: No, not after I leaned it out.

Doctor: Aha! Did you try leaning slightly before or during the take-off?

Owner: Well no, the airport elevation was only 2300 feet.

Doctor: Ah, but what was the density altitude?

Owner: How should I know?

Doctor: There are formulas and prepared tables for computing density altitude. If you have a flight computer you can work it out yourself. It is important. On the strength of the figures you mentioned, I would say that you were at about 4000 foot density altitude. That means that for best performance in your aircraft it may have been necessary to lean your engine slightly for take-off. Anything less than best performance would extend the take-off.

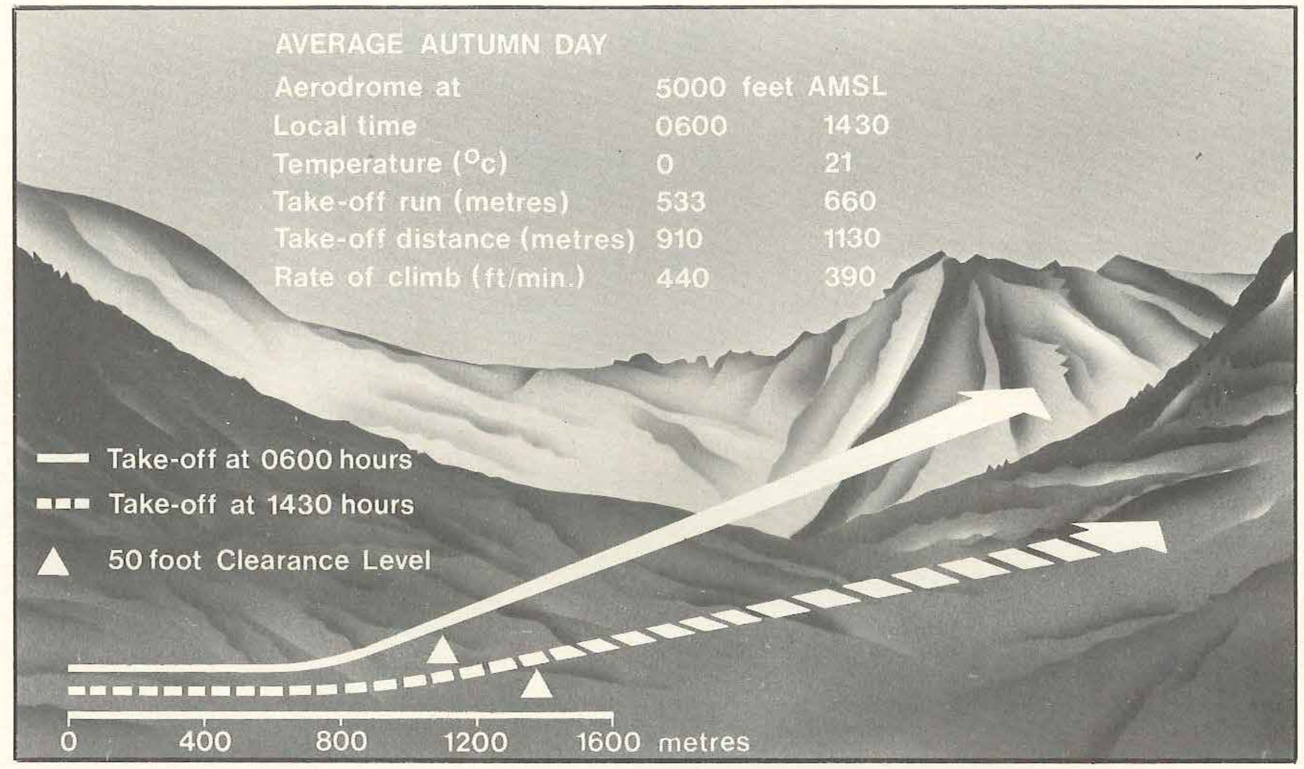
Owner: I can't believe that would make me go 300 metres past the mark. No way.

Doctor: Oh, I agree, that is only one of the factors. Let's look for some others. Temperature, for example, is critical. Where and when did you get your temperature reading.

Owner: I took it off the OAT gauge, right about noon.

Doctor: I see. And how soon after that did you take-off? Right away?

Owner: Well, no, not right away. I believe there was a little delay, we had some problem with the communications. I think I got off about one o'clock, local time.



Doctor: A full hour later!

Owner: So what? The temperature would be peaking at noon, wouldn't it?

Doctor: Not at this time of the year, where you were. Remember, on daylight saving time the sun has another hour to reach its zenith. On a clear day the temperature might peak around 1400 local or later. It so happens I attended a recent density altitude clinic like this at a place where the temperature peaked out at 35 degrees Celsius between five and six o'clock. One chap was nearly 700 metres beyond his mark before he got up to 50 feet. The actual temperature when you took off could easily have been 28 degrees instead of 24. That would make it . . . uh, 17 degrees above standard. If you check your chart I think you will find that would give you about 50 metres more needed for your take-off run.

Owner: How is that? Doesn't 15 from 28 equal 13?

Doctor: Standard temperature varies according to altitude. At 2000 feet AMSL it is not 15 but 11 degrees.

Owner: I don't think I will ever get that straight. It just doesn't make sense to me that the higher the temperature, the higher the density.

Doctor: That is not how it works. Density altitude, first of all, is a theoretical concept — not a point in space or in the sky. It happens to be very useful. Let's see if we can simplify. You know that at sea level, at what we call standard temperature (15°C) and pressure (1013.2 millibars) a block of air will always have the same density — the same number of molecules of air per cubic foot. You also know that in our atmosphere temperature declines about two degrees Celsius for every 1000 feet you climb — more if the air is dry. So at 5000 feet the standard temperature on this same day would be about five degrees, and the density of the air considerably less than at sea level.

Owner: If the air temperature is down at higher altitudes, wouldn't density go up?

Doctor: No, because gravity is also a factor here. The higher you go, the weaker the gravitational pull, the fewer molecules per cubic foot; above-standard temperatures also thin out the number of molecules per cubic foot of air. Thinner, or less dense air, makes the aeroplane act as though it were higher than the altimeter (or pressure) altitude. So density altitude is the altitude environment in terms of the actual number of molecules per volume of air, compared with the normal or standard number of molecules, in a given volume at a given elevation. In even simpler terms, it is the equivalent altitude your engine breathes.

Owner: Isn't the rest of the aircraft affected?

Doctor: Of course, the entire aircraft behaves in accordance with the density of the air — rather than according to the elevation. When density altitude is higher than pressure altitude, propeller thrust is reduced (so is drag, on the other hand), and there is less lift and less resistance to the air. True airspeed is much higher than indicated airspeed, but you may not be aware of this because normal indicated airspeed readings are still applicable for virtually all operations — stall speed, climb speed, approach, etc. The giveaway is the vertical speed indicator, which reads below normal in a climb.

Owner: Is that why you seem to climb so slowly in the mountains in summer — it's not just your imagination, and the closeness of the cliff faces?

Doctor: Precisely. And with a higher true airspeed you need more lateral room for manoeuvring, especially in valleys, and at aerodromes with runways of marginal length. Overshooting is always possible. If you try to avoid this by approaching to land at a subnormal indicated airspeed, you could easily land short.

Owner: Sounds like they've got you, coming or going.

Doctor: Not really. You simply have to make appropriate allowances for the environment your aircraft is experiencing, rather than for the altitude you read off your altimeter.

Owner: Can you ever get such a thing as negative density altitude — say in winter?

Doctor: Certainly. And not just winter, but at night or whenever the temperature falls below standard. It is computed in terms of a theoretical point below sea level. Normally it presents no problem to flying and we are not even aware of it, except perhaps in terms of increased engine performance. There is a possibility, with a controllable propeller, of overspeeding the engine, but it is slight. On the other hand, I recall one occasion where I was attempting to take off in a 172 in the dead of winter. The density altitude was computed by the tower as just about 3000 feet below sea level. Do you know, I was simply unable to get a rich enough mixture into the carburettor to get off the ground? But that's rare.

Owner: You know I was way under max gross weight, which is what most of these performance computations are based on, so that should have given me a big edge, shouldn't it?

Doctor: It helps, but unless you know exactly how much difference it makes in your aeroplane — it varies a great deal from one to another — you don't want to bank too heavily on it. Let's look at some other factors. How about the wind?

Owner: Negligible — three to five knots.

Doctor: Straight down the runway?

Owner: No, we were taking off on 19, and the wind was from the west somewhere — we didn't pay any attention to it because it was so light.

Doctor: Just the same, in a critical condition, even a very light wind off the beam could affect your take-off and climb performance if you are used to a head wind. How about the slope?

Owner: Slope? There wasn't any runway slope — at least that I heard about.

Doctor: Did you ask anyone? Many aerodromes have runways with a small degree of slope which is not mentioned in any of the official publications because no safety factor is involved. But when you are trying to be precise on your take-off — or when the surrounding terrain actually does make the operation critical — even a slight uphill slant to the runway will extend your take-off. By and large, take-offs in hill country or from mountain airports are made downhill by knowledgeable pilots, regardless of the wind. You don't ever want to try to outclimb the terrain on take-off.

Owner: Not in that crate of mine.

Doctor: Come, come, let's not blame the equipment, unless we're sure our own hands are clean. It's a good aeroplane or you wouldn't own it. Let's look a little further. What about the climbout profile?

Owner: Strictly by the numbers.

Doctor: Very good. Do you remember the airspeed when you lifted off?

Owner: Negative, but I took off just like always — trimmed her up and let her fly herself off. I never horse it up.

Doctor: Well, that's fine, under many circumstances. But if the problem is to get off and up over a given terrain obstacle, in the shortest possible distance — which often happens in mountain flying — you want to hold the aircraft on the ground until you reach the best angle of climb speed, and then lift off firmly and smoothly, holding that speed. Now what about the climbout — what was your airspeed?

Owner: Strictly by the book. Ten degrees of flaps and 82 knots, for best rate of climb.

Doctor: Best rate? Oh, dear. Oh, dear.

Owner: What's the matter?

Doctor: I'm afraid that's where you blew it. I wonder how many unfortunate pilots have racked up aircraft because they confused best rate of climb with best climb angle. It seems that the tighter the bind the poor chap gets into, as concerns surrounding terrain, the more likely he is to go to excess airspeed in an effort to outclimb the landscape. There is some fateful notion that safety lies in greater airspeed, but actually every knot you add on over the best angle of climb speed reduced your chances of getting over the obstacle. I realise the terms may be less than indicative, but somehow you must get it straight that best rate of climb means best vertical rise within a given *time*, whereas best angle of climb (with a slower airspeed) means best rate of climb within a given lateral *distance*. When it comes to clearing an obstacle, distance is the all-important factor, not time. It doesn't matter if it takes you an hour to get over a ridge, as long as you clear it safely. If you get in a hurry about it, you may run out of room in a hurry.

Owner: I guess you're right. I got so impatient finally I took the flaps off.

Doctor: Another no-no. That cost you altitude. Your plane's best angle of climb configuration calls for 35 degrees of flaps, and there is no way of getting around it.

Owner: Okay, what else did I do wrong?

Doctor: Nothing, I suspect. All those things we mentioned may seem of little consequence taken piecemeal, but when you put them together they could add up to quite a bundle — perhaps enough to spell the difference between survival and disaster in a real life situation. I suggest you set up a practice course at your home aerodrome and see how close you can come to flying the aircraft according to its specified performance ability. I'm sure you would soon see a vast improvement.

Owner: I'm not so sure. I'm a slow learner.

Doctor: Perhaps they should have given you the same consolation prize they gave the chap who recently finished last in one of these contests. At the Awards Banquet they presented him with a seedling tree which he was to plant beyond the runway of his choice. The idea being that in 50 years the tree would grow to a height of about 50 feet, and by that time, with regular practice, he would be able to fly over it safely. It was quite funny, really.

Owner: Goodbye, Doctor.

Doctor: Please don't go away angry. It was all in fun. As a matter of fact, I suspect that he — and you — were the real winners of these competitions.

Owner: How do you figure that?

Doctor: Well, I don't think the objective was really to determine the pilot who could handle altitude and obstacle clearance problems best, do you? Wasn't the point to learn something about one's flying techniques in a way that shook you up without actually exposing you to any danger? And who was more shaken than you?

Owner: No one. Goodbye again.

Doctor: Keep smiling. Next please ●

The Beech Baron D55 had been hired by a football club to convey five of their players from Perth to Norseman for a game at Kambalda. The aircraft departed from Jandakot at 0805 hours local time with the pilot and two of the players on board. It landed at Perth Airport and the other three passengers boarded the aircraft for the flight to Norseman. Shortly after arrival, at about 1000 hours, the passengers and the pilot were transported by coach to Kambalda.

During the afternoon the pilot telephoned Kalgoorlie Flight Service Unit to obtain the latest meteorological forecasts for the return flight to Perth. He was advised that there was a probability of fog developing at Perth, so he nominated a departure time from Norseman of 2100 hours, with Meekatharra as an alternate.

Arrangements were made for additional fuel to be added to the aircraft because of the possible diversion. On return to the Norseman aerodrome, at about 2000 hours, the pilot supervised the addition of 195 litres of fuel to the aircraft tanks.

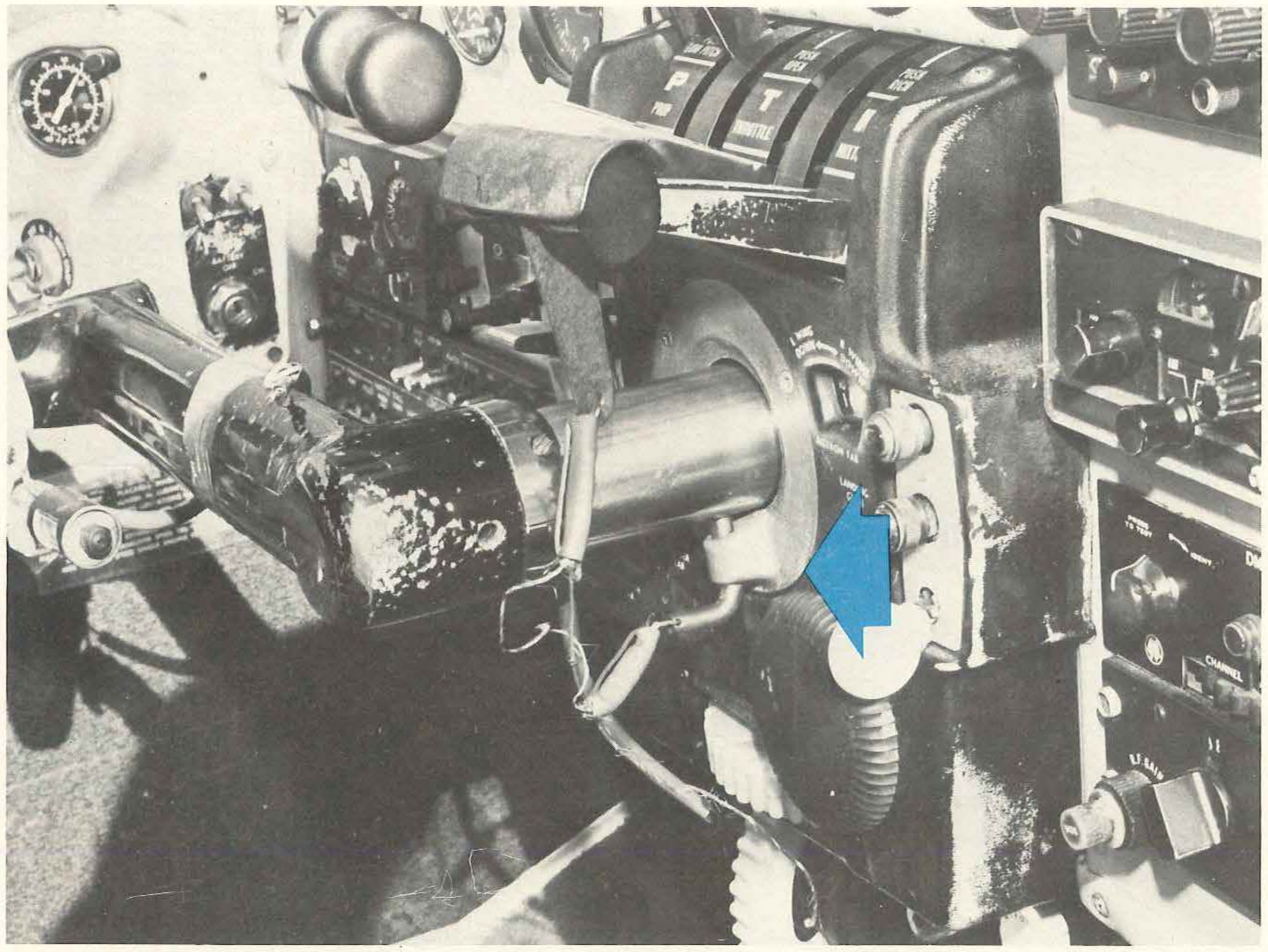
After preparing the aircraft, the pilot and passengers boarded and the engines were started. It was a clear, dark night with no moon and a slight, southerly wind blowing. The aircraft proceeded to the northern end of the main strip. Radio communications were established with Perth and the pilot reported taxying. He was advised that there was no known traffic in the area. His acknowledgement was the last communication received from the aircraft.

Bystanders indicated that each engine was run up, and the navigation and landing lights were illuminated. Take-off commenced towards the south and the aircraft appeared to become airborne in a normal manner. At about 200 feet it commenced a left turn, initially maintaining height, but, as the angle of bank increased, the aircraft descended until it struck the ground in a steep nose-down, left-wing down attitude on a northerly heading. A fierce fire broke out on impact and all occupants were killed.

Detailed examination of the wreckage during the subsequent investigation revealed no defects or malfunctions which might have contributed to the accident. There was evidence which indicated that both engines were producing substantial power at the time of impact.

The investigation did, however, reveal that the elevator and aileron control lock was at least partially engaged. This lock consisted of a steel pin normally inserted through an alloy lug on the instrument panel, below the control column shaft. It was also possible to lock the aileron and elevator controls together by inserting the pin into the control column without first passing it through the lug. In this case the aileron controls would be locked and the elevator control could be moved rearward from about the mid position but could not be moved forward.

Because the lug was destroyed by the fire it was not



possible to determine if the pin had been inserted through it; however, the pin was in place in the control column. Nevertheless, with the pin inserted in either manner, the pilot would have been denied aileron and at least partial elevator control, during both ground and air operation of the aircraft. The flight path of the aircraft as described by witnesses to the accident was consistent with the controls being locked by either of the two methods described.

The restriction to control surface operation should have been obvious if preflight, **vital** actions had been performed. The cause of the accident was therefore considered to be that the pilot did not perform adequate preflight procedures.

There could be a number of reasons why the pilot, who was apparently conscientious about his operation of the aircraft, could become airborne with the control lock in place. The tardiness of the last passenger boarding the aircraft, concern about a possible diversion due to fog at the destination, or a number of other factors could have distracted him. The actual reason or reasons for his failure to remove the lock will never be known.

The design of the control column lock was not altogether conducive to safe operation in that visual checks were inhibited by the lock being under the control column. On later model aircraft the pin is inserted through a lug above the column with the elevator control close to its full forward position. The control column lock pin in this aircraft was joined by wire to the rudder lock and the mixture control lock, and it would appear that those locks were not in position during the final operation of the aircraft.

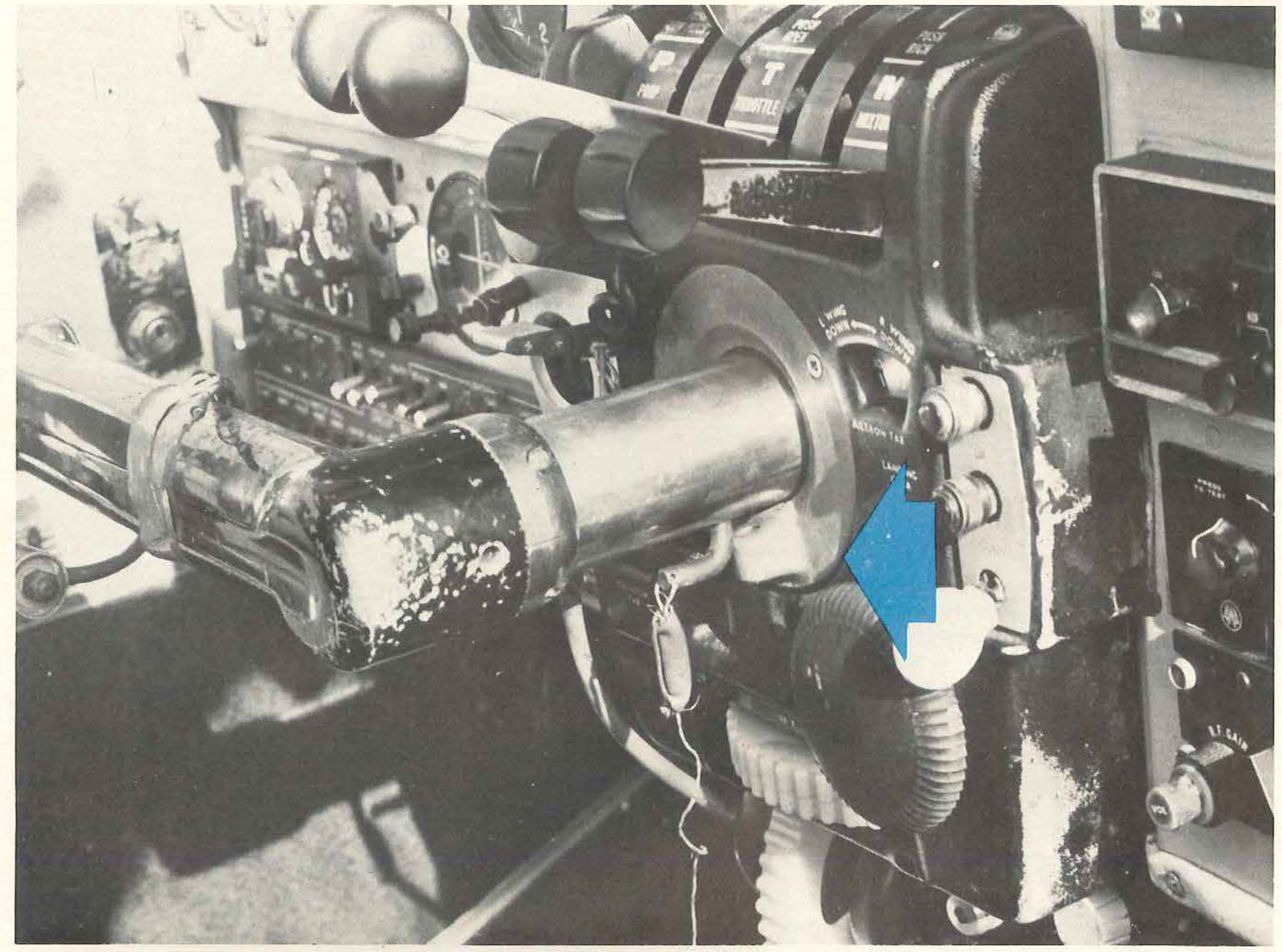
Above. Control column lock correctly fitted to the same type of Beech Baron as the one featured in the accident report. Note that the pin is inserted through the aluminium lug, thus preventing movement of both the aileron and elevator controls. Also note the separate hood over the mixture control knobs.

Opposite. Control column lock not inserted in the lug. This position locks the aileron control but allows movement of the elevator from about neutral to the full up position.

Title illustration: The type of control lock fitted to later model Beech Barons. Note that the aluminium lug is repositioned above the control column and the one lock operates on the aileron, elevator and engine controls.

Whether you call them pre-take-off checks, before-take-off vital actions or some other name, the checks recommended by the manufacturer are the minimum necessary to ensure that the aircraft will fly safely, provided nothing untoward occurs. Regardless of the type or make of aircraft they all call for a full and free check of the primary control surfaces. Without such a check you cannot be sure that control of the aircraft is going to be possible. Wherever possible, the control surface itself should be checked, as well as the movement of the control column, to ensure correct operation. In cases of low ambient lighting, as on this flight, this check should be conducted with the aid of a torch to see the control surfaces, or by making use of any available external lighting such as the security lights around the tarmac area. It may take a little more time and effort, but will be worthwhile in the long run.

An accident such as this gives tragic emphasis to the importance of these pre-take-off **vital** actions ●



In brief

The pilot of a Cessna 172 prepared to take off from a station strip before first light. His destination was the local township, 40 nautical miles south west, where he was to assist with the unloading of a truck which was required for back loading at 0700 hours local time.

There were no runway lights available and conditions at 0550 hours were completely black but the pilot, who did not hold an instrument rating, was quite confident knowing that he had conducted this kind of operation in the past *and would be flying into daylight.*

A routine daily inspection, including a fuel drain check, was carried out with the aid of a torch. The pilot set the altimeter to zero feet and, using the landing lights, lined up the aircraft and took off to the south, 36 minutes before first light. At 300 feet he visually commenced a right hand turn towards the town. The next thing he remembered was scrambling out of his very bent aeroplane.

The aircraft had struck the ground shortly after the turn was commenced, in a position that would approximate the beginning of a right downwind leg. It then cartwheeled for about 70 metres, during which the fuselage broke behind the cabin area. No evidence was found to indicate that the aircraft had been other than serviceable.

In turning on to course the pilot did not refer to his artificial horizon and the turn took him away from the east where there may have been some glimmer of light. It should be well known that without a visual horizon such an undertaking can lead to disorientation and loss of control, which probably happened on this occasion. Had the pilot been formally trained in night flying, he would have discovered that it consists to a large extent of flying by instruments.

The pilot may consider himself fortunate that in this case the only things broken were his aircraft and a few regulations ●

DC-9 lands short of runway

At approximately 1342 hours Eastern Summer Time on an afternoon in late Spring, a McDonnell Douglas DC-9-31 aircraft landed 192 metres short of the threshold of Runway 27 at Melbourne Airport, Victoria. The aircraft was conducting an Instrument Landing System approach in conditions of reduced visibility caused by heavy rain. During the ground roll to the threshold, the main landing gear of the aircraft struck and destroyed six lights in the high intensity approach lighting system serving the runway.

The aircraft was operating a regular public transport flight and there were 91 passengers and a crew of six on board. No one was injured and the damage sustained by the aircraft was minor.

The flight was operating from Brisbane to Melbourne with an intermediate stop at Coolangatta. The aircraft departed Coolangatta at 1151 on an Instrument Flight Rules category flight plan. Throughout this stage the Captain flew the aircraft from the left-hand pilot seat.

As the aircraft approached the destination area, Melbourne Airport Automatic Terminal Information Service was broadcasting information Papa. This contained the following: Runway 34, wind 340 degrees at 25 knots, gusting to 35 knots, QNH 1001 millibars, temperature 22 degrees Celsius, cloud six oktas at 2500 feet with lower patches and showers in area.

At 1334:06 the aircraft made contact with Melbourne Approach Control and was immediately cleared to descend to 3000 feet on a QNH of 1001 millibars in accordance with the altitude restrictions specified in the Distance Measuring Equipment Arrival Procedures. Approach Control also advised the aircraft it had 30 nautical miles to run to Melbourne, that the runway had been changed to 27, and that it was to track via the Epping locator and the Runway 27 localiser. Twenty seconds after acknowledging this instruction, the aircraft was advised that the wind was coming around to the west at 30 knots.

The rapid change in surface wind was associated with the passage of a cold front, crossing the Melbourne area from west to east at about 30 knots. The front had been forecast to cross Melbourne Airport between 1400 and 1600. ATC had issued an Operational Requirement for aircraft arriving between 1130 and 1930 to carry additional fuel reserves because of the weather conditions associated with the frontal passage. The DC-9 carried sufficient fuel to divert to Sydney.

At 1336:19 the aircraft was advised that the QNH was now 1002.5 millibars, visibility 2000 metres in heavy rain, wind from 240 degrees magnetic at 30 knots with gusts to 40 knots. The aircraft had 18 nautical miles to run and was cleared for ILS final on Runway 27. Nine seconds later the aircraft was further advised that QNH was 1005 millibars, cloud cover six oktas at 1500 feet with lower patches and temperature 17 degrees.

As a result of the rapid changes in QNH and surface wind, the Captain considered there was a probability of encountering wind shear during the approach. As a precaution he decided to make a faster than normal approach with only 25 degrees of flap extended. The calculated landing weight was 40518 kilograms (2709 kilograms under maximum) and the Captain referred to the 90 000 pounds (40 823 kilograms) landing weight Data Card to obtain an approach Reference Airspeed for 50 degrees of flap of 122 knots. He added a 10 knot increment to this figure to allow for the reduced flap configuration, and a further 20 knot increment to compensate for the advised strong wind gradient and gust effect. He thus arrived at a selected approach speed of 152 knots. The Captain advised the First Officer of this decision, but did not otherwise elaborate upon the manner in which the approach and landing would be carried out.

Over Epping locator at about 3000 feet neither pilot could see the runway. At about 2000 feet they could both see the airport terminal buildings and the first half of the runway, but not the control tower.

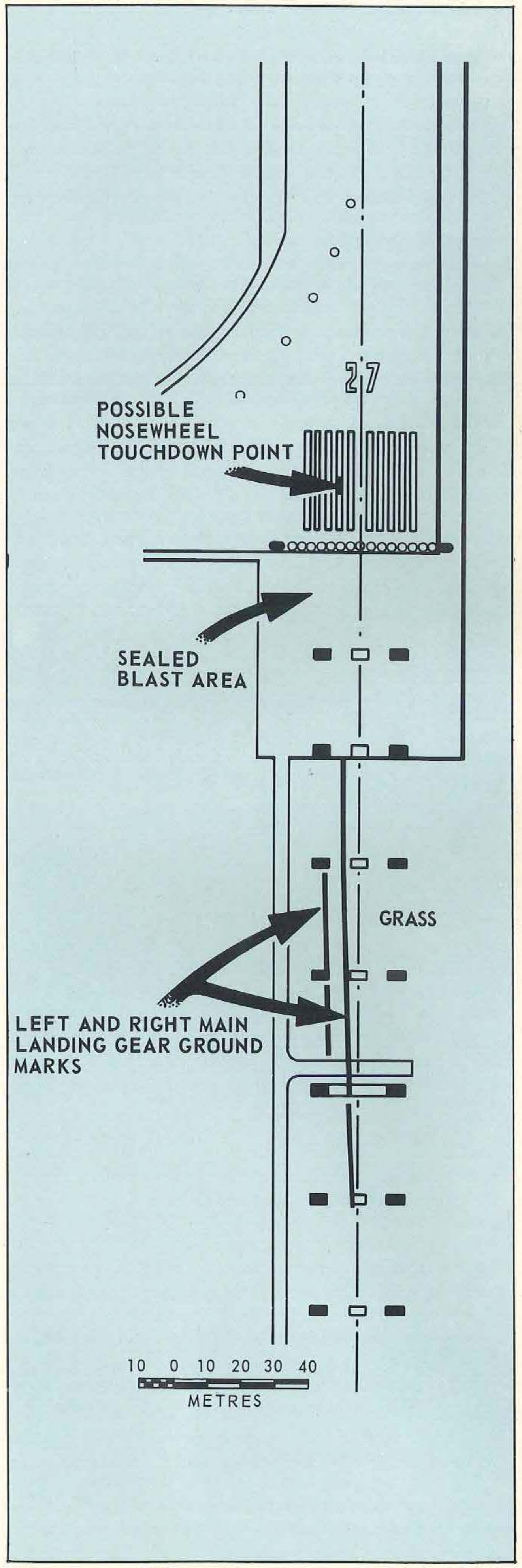
At 1339:58 Melbourne Tower advised the aircraft that it had no idea of the cloud base but it was quite low, visibility was 2000 metres in heavy rain, surface wind 250 degrees magnetic, 20 knots gusting to 30 knots. Runway and approach lighting were on stage five.

At about 1500 feet, in increasing rain, the crew adopted full instrument flight procedures. Both pilots referred to their approach charts and verbally confirmed the approach minima and overshoot procedure. The rain continued to increase in intensity and at about 1000 feet the windshield wipers were turned on. Both pilots stated the aircraft was then aligned with the localiser and on glideslope. At 800 feet (400 feet above ground level) the F/O called the descent rate, in accordance with standard company procedures. To the best of his recall it was about 650 feet per minute. He also advised the Captain that he had the high intensity approach lights in sight. The Captain looked out and also saw the lights.

From this point both pilots concentrated their attention primarily outside the cockpit. The Captain stated he supplemented this with instrument cross checks down to about 200 feet AGL, while the F/O stated he stopped monitoring his instruments about 300 feet AGL. At this last instrument check the Captain recalled the aircraft was still close to glide slope. He also stated that about 400 feet AGL the aircraft encountered wind shear. Both pilots recalled approximately 12 degrees left drift at this time.

Visibility ahead was poor. Despite operation of the wipers, the rain on the windshield blurred the pilots' vision, and both stated the approach lights were badly diffused. Neither could see the runway ahead and they concentrated on scanning for the green threshold lights.

At an estimated 100 feet AGL, still without visual contact with the threshold lights, the Captain stated he sensed the aircraft sinking rapidly. He attempted to counter this by pulling back on the control column, but did not increase power.



As the Captain rotated the aircraft the F/O sighted the right hand threshold lights and commented they were 'looking a bit low'. He could not remember making any further comment but the Captain recalled that, just before impact, the F/O said 'You are going to hit the lights'. Both pilots then felt the landing gear strike the ground and the approach lighting.

Touchdown was in a near normal landing attitude, 192 metres short of the runway threshold. Six approach lights, in the last four rows leading to the threshold, were struck by the main wheels as the aircraft rolled across the grassed area. The nosewheel probably touched down on the runway just beyond the threshold. The aircraft remained on the runway as it slowed down and taxied to the terminal under its own power. The passengers disembarked by normal means.

Meteorological information

The crew of the DC-9 had received all the relevant enroute and terminal forecasts, including an updated terminal forecast issued at 1102. This indicated a surface wind of 340 degrees magnetic at 20 knots, with gusts to 45 knots, visibility of 10 kilometres or greater, rain, three oktas cumulus base 4000 feet and seven oktas altocumulus/altostratus base 10 000 feet. A rapid change would occur between 1400 and 1600 to: surface wind 200 degrees magnetic at 15 knots, visibility 10 kilometres or greater, rain showers, six oktas stratus base 700 feet and five oktas cumulus base 2000 feet. During the period 1200 to 1900 there would be temporary reductions of up to one hour duration in visibility to 3000 metres, associated with thunderstorm activity and three oktas of cumulo-nimbus, base 4000 feet. Surface temperature and pressure over the forecast period were 23/16/15/14 degrees Celsius and 1002/1004/1006/1008 millibars respectively.

Bureau of Meteorology procedures require that a forecasting service be provided in respect of low level wind shear. Although conditions associated with the frontal passage indicated a high probability of wind shear a forecast to this effect was not issued.

Observations at Melbourne Airport at 1300 noted conditions substantially the same as the forecast. By 1330 the low level cloud had increased to seven oktas at 3000 feet with lower patches. A marked roll cloud and heavy rain was visible approaching from the west.

About 1334 the front crossed the airport, the wind backing to 240 degrees magnetic at 28 knots with gusts to 39 knots. Approximately one minute later heavy rain commenced and a total of 12 millimetres was recorded in the next 20 minutes. At about 1336 the surface pressure rose two millibars to 1005 millibars over a 30 second interval.

By 1400 conditions had moderated, and some 20 minutes later the rain reduced to occasional showers, with visibility of 25 kilometres and no cloud below 1500 feet.

The aircraft was twice advised that visibility was 2000 metres. Aerodrome controllers and meteorological observers refer to a series of landmarks at known distances from the control tower to estimate visibility. It is a requirement that when visibility is less than 2000 metres, Runway Visual Range is used. This information is obtained by despatching an officer to the runway threshold to gauge RVR by reference to specific assessment lights.

There was evidence that for a period the visibility reduced below 2000 metres. At about 1339 the visibility from the tower was probably about 1100 metres to 1300 metres, and at 1340 the Meteorological Observer in the control tower recorded the visibility as 1500 metres. However, the Aerodrome Controller did not despatch an officer to the Runway 27 threshold to assess the RVR.

Ground facilities

Runway 27 has a Calvert pattern high intensity approach lighting system with associated runway lighting, variable over six stages, to ICAO Category 2 standard. The threshold is marked by a row of green lights flush with the surface of the runway and spaced at intervals across it. The ILS is Category 1 standard with a glideslope angle of three degrees. The associated middle and outer marker beacons and the Epping locator are aligned with the centreline and are 1074 metres, 6963 metres and 15760 metres respectively from the threshold.

All navigation aids and lighting systems were operating normally and the minima applicable to this approach were 700 feet ceiling (293 feet above Runway 27 threshold) and 1200 metres visibility.

Flight path

From the Flight Data Recorder trace and meteorological analysis the aircraft was determined to have passed through the front at 1340:50, 70 seconds before touchdown.

The following reconstruction of the approach was made. All times are in seconds prior to touchdown.

The aircraft passed over Epping locator at 175 seconds, descending through 2950 feet on a heading of 268 degrees magnetic but closing the localiser from the north under the influence of the strong northerly wind. IAS was about 235 knots and decreasing. Glideslope was captured from below at 165 seconds. Descent continued with minor deviations of about half a dot on the glideslope (each dot equals 0.25 degrees deviation) until 95 seconds. During this period the localiser was captured and maintained at an aircraft heading of 275 degrees magnetic. The IAS had continued to decrease but at a slower rate and at 95 seconds was about 180 knots, still some 30 knots above the selected approach speed. The aircraft altitude was about 1830 feet; an average rate of descent since passing Epping locator of 840 feet per minute. There were still some 8000 metres to run to the runway threshold.

The rate of descent was then reduced and the aircraft began to deviate above the glideslope. At the same time a left turn of approximately five degrees was made and the aircraft also began to deviate left of the localiser. The Outer Marker was crossed at 83 seconds. At 75 seconds the aircraft encountered wind shear associated with passage of the front. The IAS increased approximately 15 knots to 195 knots over a 10 second period. This was accompanied by a brief pause in descent which caused the aircraft to be displaced some two dots above glideslope.

The aircraft then entered a descent at about 1200 feet per minute and began to turn to the left. Drift to the left had ceased and the localiser was closed at approximately 60 seconds. A more rapid left turn on to 255 degrees magnetic was then made, and this caused the aircraft to deviate left of the localiser by one dot on the course deviation indicator (each dot equals 1.25 degrees of localiser deviation). Immediately after this turn the rate of descent increased to about 1500 feet per minute, and this expedited closure of the glideslope. However as the high descent rate was maintained the aircraft passed through the glideslope at approximately 38 seconds. At this time a right turn to heading 267 degrees magnetic was commenced.

By 30 seconds the aircraft was some two dots below glideslope and approaching the minimum altitude of 700 feet. The descent was halted and this altitude maintained until the aircraft was back on glideslope at about 20 seconds. The descent was then resumed at an initial rate of 900 feet per minute. Throughout this period the IAS remained in the 175–180 knots range.

During the last 20 seconds of flight the rate of descent increased and averaged some 1100 feet per minute over this period. The aircraft remained approximately on localiser but rapidly dropped below glideslope. The IAS fluctuated downwards, but at touchdown was still 171 knots.

Operating procedures

Company operating procedures required cross checking between the two pilots, and alerting by the pilot not flying of IAS variations of five knots from the selected approach speed and of rates of descent in excess of 800 feet per minute when below 1500 feet above aerodrome level. Aircraft were also required to be established on glideslope in the landing configuration at the selected airspeed not less than 700 feet above airport level.

The Company's standard instrument approach procedure was the monitored approach. In this procedure the F/O flies the approach and remains 'on instruments' throughout the approach, even if the aircraft enters visual flight conditions and the Captain assumes physical control to complete the landing. The Company Operations Manual covered this procedure, reaffirming the cross check requirements laid out in the general section covering all approaches. It also stated that the monitored approach procedure could be discontinued any time at the Captain's discretion.

The Company Flight Training Manual instructed that VRef be increased in strong wind conditions by 50 per cent of the gradient wind plus 100 per cent of the gust factor, to a maximum total of 15 knots. This maximum had been reduced from 20 knots some four weeks prior to the incident.

Both manuals indicated that landings were to be made with 50 degrees of flap extended. The only exception was for single-engine approaches when flap extension was to be limited to 25 degrees. In this case the VRef for 50 degrees flap should be increased by 10 knots and there would be a markedly higher body angle, of about six degrees, on approach. Neither manual contained instructions to be followed when wind shear was expected.

The first information to indicate a need for IFR procedures was at 1336:19 when the aircraft had some 30 kilometres to run, and Approach Control advised of reduced visibility and heavy rain. Possibly the pilots regarded this sudden deterioration as a transitory event. Subsequently they had the first half of the runway in sight from 2000 feet and this may have been an influence. Instrument procedures were not fully implemented at 1500 feet when the crew accepted that a visual approach was not possible. This was considered a major factor in the incident. The monitored approach procedure was not initiated, and the lack of detailed alternate procedures in the Operations Manual could possibly have been an influence in the resultant unco-ordinated actions by the flight crew. This omission was not classified as a factor in the incident in view of the crew's general neglect of published procedures.

It could not be established what cross checks, if any, occurred as required by the Operations Manual. Either the F/O did not monitor the instruments, or he noted the abnormal indications and elected not to alert the Captain, or, having issued the alerts, was ignored by the Captain. Whichever was the case, it was evident that a major breakdown in crew co-operation and co-ordination occurred during the approach.

It was considered that final approach should have been delayed, at least long enough to evaluate the rapidly changing weather situation, and plan and brief appropriate instrument approach procedures. The Operations Manual implied that the approach should have been abandoned when stability, particularly in respect of approach speed, had not been established by 700 feet AGL.

The decision to continue beyond the minimum altitude was dependent on the Captain's assessment that adequate conditions existed for visual flight, and that forward visibility was 1200 metres or greater. Flight visibility at the minimum altitude could not be precisely established but was considerably less than that necessary to fly by external reference alone. It was considered that failure to recognise that situation and to initiate a go-around was the primary causal factor in the incident.

In considering the circumstances of the final large deviation below glideslope, it is significant that neither pilot monitored the aircraft instruments. By attempting to fly solely by reference to the runway approach lights the crew risked their judgment being influenced by illusory effects resulting from the heavy rain on the windshield. Research into this phenomenon indicates a depression of the 'horizon' by up to 1:12. The gradient from the 'on glideslope at minimum altitude' point to where the aircraft touched down was 1:14. Whilst not conclusive evidence of visual illusory effect, it was considered this possibility could not be excluded.

Analysis

General meteorological conditions were essentially as forecast. Frontal passage was earlier than predicted. Ground visibility was reduced to between 1100 and 1500 metres at the time the aircraft made its approach, rather than the 3000 metres forecast. The Bureau of Meteorology omitted to issue a forecast of wind shear as was required. This was not considered to be of significance as the crew were aware of the probability of wind shear on final approach.

Twice during the approach the aircraft was advised that visibility was 2000 metres. On the second occasion the visibility from the tower was probably 1100 to 1500 metres. A specific reason for the incorrect advice was not established, but probably the Aerodrome Controller had restated his initial evaluation and had not assimilated the visual cues that indicated the figure of 2000 metres was no longer valid. As an RVR assessment was not made, it was not established if the minimum required 1200 metres existed at the time of the incident. Had an RVR of less than 1200 metres been determined, then the runway should have been closed. Alternatively, an assessment of 1200 metres or greater would have permitted authorisation of the approach and landing. The advice of marginal RVR accompanying such a clearance might have provided a timely warning to the crew of possible lack of outside reference below minimum altitude. It was concluded that the Aerodrome Controller's omission contributed to the incident, but only insofar as the flight crew was not provided with secondary information to assist in assessing the adequacy of landing visibility.

There were no abnormal pressures on the flight crew to complete the flight without delay, but the evidence suggests that there was some haste in the manner in which the approach was flown. A non-standard configuration of 25 degrees of flap was chosen and a high selected approach speed of 152 knots calculated. Throughout the approach an IAS of some 20 to 30 knots higher than that selected was maintained.

It is possible that the excessive airspeed reflected a lack of familiarity with, or consideration of, the aircraft's performance in the 25 degrees flap configuration. Simulator tests indicated negligible difference in body angle and required power between the 25 degree flap/170 knot IAS and the 50 degree flap/140 knots IAS approaches. If during the approach the Captain had selected an attitude and power setting equating to the 50 degree flap configuration with which he was more familiar, then the aircraft would have achieved an airspeed of the order recorded on the FDR.

The use of the reduced flap approach is not a commonly accepted counter for wind shear. This particular approach, with the wind backing from the north to the west, encountered a predictable overshoot shear condition. A reduced flap and higher airspeed would compound the problem of recovery as a greater power reduction would be necessary to correct for the unwanted energy gain. The lack of reference material on wind shear in the operator's manuals left the formation of the best approach procedure to the Captain, possibly based on an incomplete understanding of the wind shear phenomenon.

The omission of a pre-approach briefing and the delay in checking the approach charts until about 1500 feet on final approach indicated that the pilots were largely employing non-instrument procedures. Their initial arrival expectancy was probably based on information Papa, which indicated visual flight conditions could reasonably be expected no lower than 2500 feet.

The Captain reported that he 'sensed' the aircraft sink. This was probably the result of wind gust effects. It seems likely that the Captain recognised a gust induced sink in sufficient time to rotate the aircraft to approximately a normal landing attitude, but not sufficiently early to significantly reduce the final rate of descent. The F/O's warning calls may also have caused the Captain to apply back-control input. Consequently the touchdown was not sufficiently severe, or in such an attitude, as to cause structural failure.

Conclusions

The investigation into the incident reached the following conclusions:

1. ATC provided the aircraft with advice of the rapidly changing weather conditions at the airport, except that the minimum visibility advised was 2000 metres when actual ground visibility from the tower was probably in the range 1100 to 1500 metres.
2. ATC did not comply with procedures that required the assessment of RVR when visibility was below 2000 metres, and the determination that RVR was at or above the specified minimum of 1200 metres before authorising an approach and landing.
3. The company's manuals did not contain procedures to be adopted when wind shear was encountered or expected. Nor did they contain procedures to be employed when a Captain elected not to carry out the monitored approach procedure.
4. The Captain elected to make a landing approach during the period of frontal passage and selected a non-standard configuration of 25 degrees flap. This was unsuited to the predictable conditions met.
5. A detailed approach briefing was not carried out prior to commencement of the approach, nor was the specified Monitored Approach procedure adopted.
6. The approach was unstable throughout, with IAS generally some 20 to 30 knots in excess of the selected approach speed.
7. Wind shear associated with the frontal passage was encountered at an altitude of approximately 1650 feet, about eight seconds after the aircraft passed over the outer marker beacon. As a result the aircraft became displaced from the glideslope but the correct descent profile was re-established at about the minimum altitude.
8. The approach was continued below the minimum altitude although external reference to safely complete a visual landing had not been established. The existing flight visibility was less than the specified 1200 metres minimum.
9. There was a major breakdown in crew co-ordination. As a result the flight instruments were not monitored below the minimum altitude.
10. The aircraft's rate of descent increased to average approximately 1100 feet per minute during the final 15 seconds of flight. An illusory effect, induced by heavy rain on the windscreen, and wind gust activity may have contributed to this high rate of descent.

Cause

The probable cause of the incident was that the approach to land was continued below the minimum altitude, when external reference was insufficient to permit the completion of a safe landing. ●

(Condensed from Department of Transport Incident Investigation R port No. 79-2.)

From the incident files

Who has control — the pilot-in-command or the owner?

The aircraft was on a private VFR flight; on board were the nominated pilot-in-command who held a private pilot licence, the aircraft owner who held a restricted PPL and the owner's wife, occupying a back seat.

The flight proceeded normally from the departure point to an en route stop for fuel. One hour and 25 minutes after departing from the refuelling stop, the pilot passed a position report to Flight Service with an estimate for his destination in another 15 minutes. Nineteen minutes later the pilot reported that he was unsure of his position. After liaising with a country police station, Flight Service established that the aircraft was over an aerodrome about 40 nautical miles short of its destination. The aircraft landed there safely, nearly an hour after its ETA at the destination.

Subsequent investigation of the incident revealed that, after the refuelling stop, there was a considerable amount of smoke haze which restricted visibility along track. Because of this haze, the aircraft was climbed to 6000 feet; the pilot informed Flight Service of the amendment from the planned altitude of below 5000 feet. The pilot-in-command was navigating the aircraft and the owner was flying from the left hand seat.

The two pilots believed they had identified the first two check points; however, a subsequent examination of the flight plan showed that the first leg of 26 miles was covered in 17 minutes, i.e. a groundspeed of 92 knots, while the second leg of 33 miles was supposedly covered in 13 minutes, i.e. a groundspeed of 152 knots. On this basis it seems most unlikely that both check points could have been properly identified.

It is questionable that, after the first check point, the pilots obtained a positive fix. Although the owner had not commenced his navigation training he had read about the radio compass and had been taking ADF bearings throughout the trip. Instead of maintaining flight planned headings and map reading correctly, the owner was attempting to navigate using the ADF.

The pilot-in-command, although not formally trained on the use of the radio compass, did know that when tracking to a station it was not satisfactory just to keep 'the needle on the nose'. This was apparently what the owner was doing. As the flight progressed, the pilot-in-command virtually gave away the navigation of the aircraft to the owner.

The situation in the aircraft was rather tense with the pilot-in-command wishing that the owner would turn off the radio compass and concentrate on flying the correct headings. The owner was rather insistent about the way the flight was to be conducted and the pilot-in-command felt uneasy about disagreeing, particularly with the owner's wife also on board the aircraft. Consequently, he virtually relinquished his responsibilities as pilot-in-command, i.e. to ensure the safety of the aircraft and its occupants.

It is essential that whenever there are two pilots occupying the control seats of an aircraft, the division of responsibilities must be clearly defined and, in particular, it must be understood which pilot is in command. This aspect of flying safety is of paramount significance when a pilot, other than the pilot-in-command, has some vested interest in the aircraft or its operation.

If you are pilot-in-command, assert your authority whenever this is necessary and ensure that you retain control of the operation of the aircraft at all times ●

Lack of briefing leads to passenger injury

The Piper Navajo was on a scheduled service and was cruising at 1500 feet when it encountered some isolated, severe turbulence while passing between two rain showers. One of the passengers, an elderly gentleman, was thrown up from his seat and struck his head on the overhead lights, receiving a severe gash. The passenger was not wearing his seat belt.

Investigation of the incident revealed that the seat belt sign had been illuminated throughout the flight but the pilot had not briefed the passengers about the use of seat belts either before flight or over the public address system during flight. There was no cabin attendant on board. The injured passenger suffered from poor vision as a result of a past double cataract eye operation. He wore dark glasses and could not see the seat belt sign. It appears that he had not worn his seat belt at any stage of the flight. After the aircraft landed a doctor attended to the passenger's injury which required twelve stitches.

The important lesson arising from this unfortunate incident is that any pilot in charge of an aircraft carrying passengers should ensure that all means possible are used to alert them to hazardous situations. Preflight briefing on the use of seat belts, observation of warning signs, use of emergency exits, etc., should be conducted before every flight. Never assume that passengers know about these things. Use of the PA system and cabin attendants, if available, will also ensure that instructions are complied with as required.

The lesson to be learnt from this incident applies equally to private or commercial operations, in small or large aircraft. A pre-flight briefing or even a short PA announcement may have prevented this passenger's injury. The incident could also serve as a useful example for pilots to present to their passengers as evidence of the degree of possible injury which may be suffered if warning signs are not heeded ●

Impatient pilot plus flat nosewheel oleo results in suspected control problem

About five minutes after departing Parafield in his Cessna 206, the pilot advised Adelaide Flight Service that he was returning because of a suspected rudder trim malfunction. He confirmed that operations were otherwise normal. In accordance with standard procedures, an Uncertainty SAR phase was declared and the Fire Service alerted. The aircraft landed normally and the phase was cancelled.

During the investigation it was established that the pilot had unexpectedly arrived at the servicing organisation, late in the day, to collect the aircraft and fly it back to base. During his preflight inspection he noticed that the nosewheel oleo strut was flat. The LAME, who had left for his home, was sent for but the pilot decided not to wait as the aircraft was loaded with some refrigeration equipment which was required urgently back at base. The LAME returned to the airport just as the aircraft was departing.

When the aircraft returned after the incident, the pilot reported that the rudder and pedals had gone over to one side. The system was thoroughly checked and it was concluded that, because of the flat oleo, the lower-than-normal pressure had prevented the nose strut from extending and locking in the fore-and-aft position after lift off. The fact that the nosewheel was still free to turn prevented the steering bungee from providing a self-centring force to the rudder system, possibly accentuated by air flow over the unlocked nosewheel.

The nose oleo was inflated and the system operated normally. New 'O' rings were subsequently fitted to the oleo strut ●

DURSTIN by Russ Day (courtesy of *Flight Crew* magazine Spring 1979)

Survey of accidents to Australian civil aircraft 1978

The Australian aviation industry is obliged to report all accidents and incidents involving civil aircraft, and the Department's air safety investigation system is based on this premise. The article 'Air Safety incident reporting — the Australian system' in *Aviation Safety Digest 109* explained the way in which accident and incident reports are stored and used.

One source of accident prevention information is the statistical analysis of recorded accident/incident data. A *Survey of Accidents to Australian Civil Aircraft* is published annually by the Air Safety Investigation Branch of the Department; the 1978 edition was recently released and is available from outlets of the Australian Government Publishing Service. It contains a wealth of statistical detail in respect of the 1978 accident record, including types of accident, pilot experience, assigned factors and so on, for airline, general aviation and gliding operations.

The Survey also contains a section devoted to a review of accident rates and activity data over past years for all categories of airline and general aviation flying, thus giving an indication of the changes which have occurred in flying activity and accident rates over the past ten years. The 1978 Survey marks a departure from previous editions in that accidents to Australian registered aircraft based in Papua New Guinea prior to that country's independence in 1975 have now been removed from the statistical presentation. The result is a more accurate picture of trends applicable to present Australian operations, and our readers may be interested to see the graph and tables presented here.

The graph in particular gives a picture of the overall trends in general aviation. Five year periods are used for trend assessment because there can be substantial random fluctuations in accident numbers from year to year, as may be seen from the tables.

General aviation activity has increased at a rate of about six per cent per year over the period covered by the graph and the accident rate per 100 000 hours flown has decreased at about five per cent per year. Provisional figures for 1979 indicate that this trend is being maintained.

The following data refers only to aircraft accidents, the definition of an accident being:

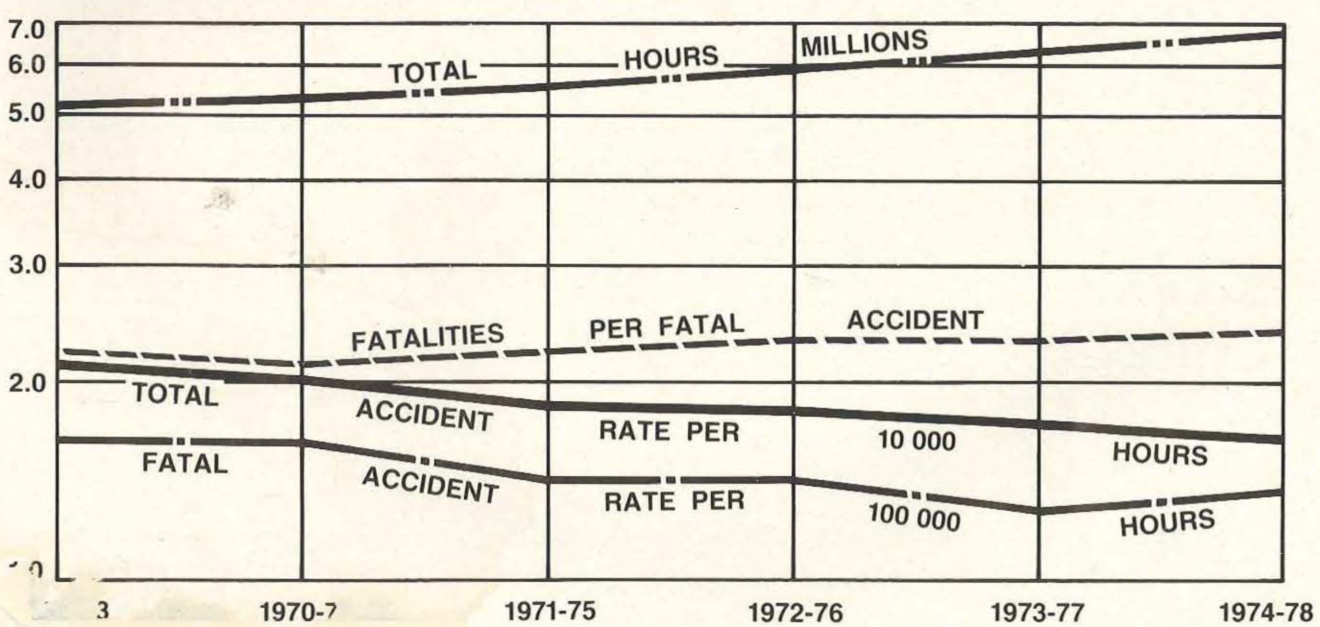
An occurrence associated with the operation of an aircraft which takes place between the time that any person boards the aircraft with the intention of flight until such time as all persons have disembarked, in which,

(a) a person is fatally or seriously injured as a result of being in or upon the aircraft or by direct contact with the aircraft or anything attached thereto, except when the injuries are from natural causes, are self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or,

(b) the aircraft incurs substantial damage or is destroyed; or,

(c) the aircraft is missing or is completely inaccessible. (An aircraft is considered to be missing when the official search has been terminated and the wreckage has not been located.)

Five year averages of general aviation accident and fatality rates. 1969-78



Airline operations

Accidents, aircraft damage, injuries and accident rates — 1974-1978

	1974	1975	1976	1977	1978
Accidents					
Involving fatalities	0	1	0	0	0
Involving serious injury	2	1	0	0	0
Involving minor/no injury	1	3	0	1	0
Total	3	5	0	1	0
Aircraft damage					
Destroyed	0	1	0	0	0
Substantial	1	3	0	1	0
Minor/none	2	1	0	0	0
Fatalities					
Passengers	0	8	0	0	0
Crew	0	3	0	0	0
Total	0	11	0	0	0
Fire after impact					
Fatal accidents	0	0	0	0	0
Non-fatal accidents	0	0	0	0	0
Injuries					
Fatal	0	11	0	0	0
Serious	3	1	0	0	0
Minor/none	155	220	0	381	0
Hours flown (thousands)	399.4	393.1	357.0	362.6	370.4
Accident rates (per 100 000 hours flown)					
Total	0.80	1.35	0	0.29	0
Fatal	0	0.27	0	0	0
Number of aircraft on register at 30 June	157	156	151	145	136

General aviation operations

Accidents, aircraft damage, injuries and accident rates — 1974-78

	1974	1975	1976	1977	1978
Accidents					
Total	234	190	243	221	249
Fatal	17	12	19	19*	27
Aircraft damage					
Destroyed	33	28	32	30	49
Substantial	199	162	214	188	199
Minor/none	4	2	0	4	2
Fatalities					
Crew	18	12	21	18	26
Passengers	21	15	32	20	26
Others	0	0	0	5	6
Injuries					
In Aircraft					
Fatal	39	27	53	38	52
Serious	18	21	13	12	31
Minor/none	489	405	542	457	544
On Ground					
Fatal	0	0	0	5	6
Serious	1	0	1	5	0
Minor	3	0	0	3	1
Fire after impact					
Fatal accidents	5	6	7	4	10
Non-fatal accidents	6	4	5	2	6
Hours flown (thousands)	1 150.8	1 206.8	1 346.6	1 512.8	1 518.4
Accident rates (per 100 000 hours flown)					
Total	20.33	15.74	18.05	14.61	16.40
Fatal	1.48	0.99	1.41	1.19	1.78
Number of aircraft on register at 30 June	3 887	4 113	4 208	4 726	5 250

*Includes one suicide; not included in accident rates