AUSTRALIAN DEPARTMENT OF TRANSPORT

Number 99 1977

AVIATION SAFETY DIGEST

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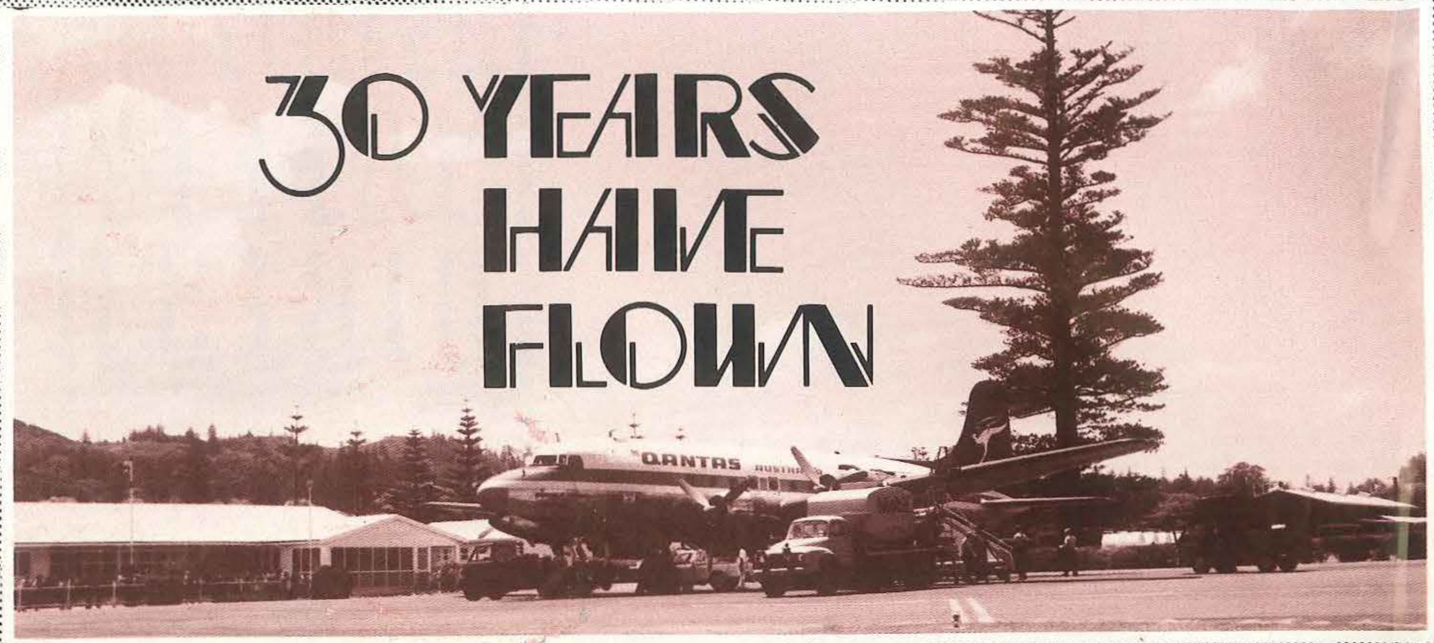
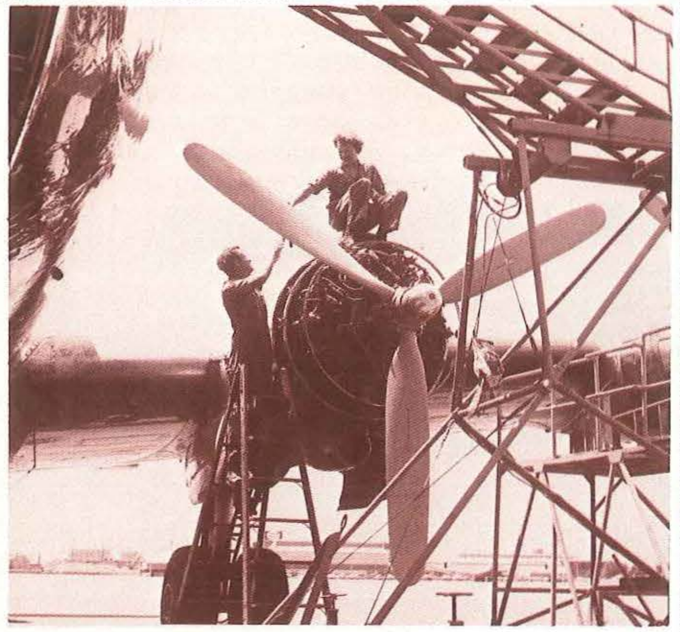
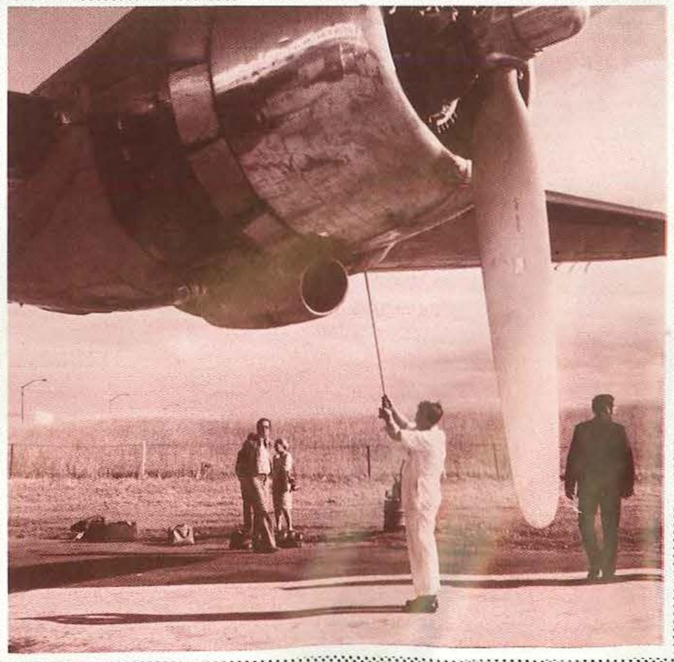
30 YEARS HAVE FLOWN







On the map, or from the air, the tiny speck that is Norfolk Island seems lost in the immensity of the Pacific Ocean. Nine hundred miles from the mainland of Australia, it seems the very embodiment of the word 'isolation'. Yet, isolated as the island may be geographically, the people and culture of Norfolk are closely tied to those of the Australian continent.

For a people so distanced from their fellows, transport and communication links remain particularly vital. Before the Second World War, the only communication with the island was by ship. Needless to say, this separated the island from the outside world by several days. It was only during the war that an airstrip was completed there. Then, in October 1947, Qantas began operating a regular service to the island, using Lancastrian aircraft, civilian versions of the famed Lancaster bombers. So began an operation which was to last for thirty years.

Two years after the service began, in 1949, the faithful but spartan Lancastrians were replaced by DC-4s, which were to continue flying the island route for nearly twenty-eight years.

When first introduced to the run, the DC-4 was a revolutionary aircraft. New, luxurious by previous standards, big; they could carry many more passengers further than any previous aircraft. They were built to last. And last they did. Today, dwarfed by their modern descendants, they seem a little out of place, out of time. Yet they have flown for a generation, and their record will be hard to better.

It is easy to understand, then, that the last DC-4 flight out of Norfolk Island earlier this year was a nostalgic occasion both for the people of the island, and for Qantas, which was bowing out of the route. Regular passenger flights to the island will continue, of course, carried on by East-West Airlines using Fokker Friendship 500 aircraft. But with the last Qantas flight, a unique and memorable era ended for the people of Norfolk Island.

Photographs by courtesy of Peter Ricketts

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

friendship crashes during attempted missed approach

While attempting to go around from a night approach to land at Bathurst, N.S.W., during a local squall, a Fokker Friendship descended on to the ground and slid to a stop extensively damaged. Both pilots and six of the passengers were slightly injured but the other 26 occupants escaped injury.

At the time of the accident the aircraft was flying the return leg of a regular public transport service between Sydney and Orange. On this service, Bathurst is a scheduled port of call during the return flight.

The Friendship had departed from Orange at 1810 hours, cruising for this very short leg at the lowest safe altitude of 5250 feet. Scattered cumulus cloud with tops to 10 000 feet was forecast for the route, but there was no cloud beneath the aircraft and the night visibility was unlimited.

Approaching Bathurst, the crew called their company representative at the Bathurst airport terminal and were informed that the wind was from the north-east at about five knots and that the QNH was 1021 millibars. With the lights of the city of Bathurst as well as the runway lights clearly visible, the crew commenced a visual descent, intending to overfly the aerodrome for a left hand circuit to runway 17. But when the captain sighted what appeared to be a light shower a little to the east of the runway 35 threshold, he decided instead to make a left hand circuit to runway 35.

The aircraft called Sydney and cancelled its SARWATCH then, in smooth conditions, with the undercarriage and 26.5 degrees of flap extended, turned on to final approach to runway 35. No drift was evident at this stage. Shortly afterwards the aircraft encountered light rain. As it crossed the Western Highway, some 730 metres south of the threshold at a height of about 300 feet, the aircraft entered light to moderate turbulence, and began to drift to the left.

With the aircraft's heading adjusted, the approach continued. The rain increased to heavy and as the aircraft neared the threshold, the drift also increased, carrying the aircraft to the left of the runway alignment. Seeing that they were not in a good position for landing, the captain instructed the first officer, who was flying the aircraft, to go around. The first officer pushed the power levers fully forward and rotated the aircraft to the normal climb attitude on instruments, while the captain raised the flaps to the take-off position and retracted the undercarriage.

In turbulence and heavy rain the aircraft maintained height for a short time, but then the airspeed decayed and the first officer was forced to lower the nose, though still maintaining a climbing attitude.

Decreasing to 73 knots, the airspeed remained at this figure for a few seconds. Then, as the turbulence ceased, it rapidly increased to about 85 knots. But as it did so, there was a heavy impact from the rear of the aircraft as the tail struck the ground. Almost immediately there was a confusion of noise and violence as the aircraft fell on to its belly and slid along the ground, tearing its way through fences. The starboard engine was wrenched from its mountings in a flash of flame, and the aircraft finally skidded to a halt in the darkness alongside a farm machinery shed, 625 metres from the first point of impact.

As the passengers and crew left the wrecked aircraft through the emergency escape hatches, they found that the rain had almost ceased and there was only a light breeze from the south.

* * * * *

Examination of the aircraft did not reveal any defect or malfunction which could have contributed to the accident.

The evidence of ground witnesses, passengers, and crew clearly indicates that at the time the aircraft turned on to final, the approach was normal and that the weather conditions in the immediate vicinity of the runway were fine. It is also evident that, as the aircraft continued its approach, an intense localised meteorological disturbance, with strong winds and heavy rain, was moving from right to left across the runway threshold. At the time of the attempt to go around, the aircraft was traversing this disturbance and by the time it had come to rest after striking the ground it had passed beyond the influence of the disturbance.

Correlation of all of the evidence, including that derived from the aircraft's flight recorder, indicates that the effect of the disturbance first became apparent about 52 seconds before impact when the aircraft was some 730 metres from the threshold at a height of about 300 feet with the airspeed fluctuating around the planned target threshold speed of 95 knots. As the aircraft entered the disturbance, turbulence was experienced, the rain increased in intensity, and the aircraft began to drift to the left of the runway alignment, necessitating a heading change of about four degrees. The descent continued until 34 seconds before impact at which time it is calculated the aircraft would have been some 125 metres short of the threshold with the wheels some 30 feet above the terrain. Seconds beforehand the airspeed had reduced to the minimum target threshold speed of 88 knots. The rain then became more intense, gusts were encountered, and the aircraft drifted further to the left, resulting in a heading correction of eight to ten degrees. The flaps had not been lowered more than 26.5 degrees, but this was consistent with the captain's prerogative not to lower full flap at 300 feet if he was not assured of completing a landing.

At this stage, the aircraft flew level for about 10 seconds. According to the passengers, there was then a substantial increase in engine noise, together with a noticeable change in the aircraft's attitude, and the undercarriage was retracted. From all the evidence, it is concluded that the go-around was begun some 24 seconds before impact from a position about 200 metres north of the runway threshold and 45 metres to the left of the centreline at a height of less than 50 feet. The airspeed at this stage was 88 to 90 knots.

Witnesses on the ground indicated that when the aircraft was on short final approach, a strong northerly wind of 30 to 40 knots began to blow, bringing heavy rain. However, a few seconds after the aircraft began to go around, the wind began to change and rapidly became a southerly of about the same intensity. It was calculated that the aircraft's groundspeed at impact was 114 knots, and that the wind was blowing at that time from 144 degrees magnetic at 40 knots, producing a tailwind component of 28 knots. Similarly, calculations indicate that at the time the go around was commenced the wind was from 030 degrees magnetic at 32 knots, providing a headwind component of 27 knots. In short, when the aircraft commenced to go around, it was experiencing a headwind component of the order of 30 knots. As the aircraft attempted to climb away, the wind fell away to almost nothing, and in the final seconds of the flight, was replaced by a tailwind component of the order of 30 knots.

Although the crew believed that full wet power was being developed by the engines, the engine fuel trim units were found in the 60 percent trim-up positions during the wreckage examination. It could not be determined if the water methanol supply, which would have enabled the engines to develop full wet power regardless of the trim settings, had been switched on for the go around, but the pitch setting of the propeller blades when they first struck the ground immediately after the initial impact suggested that the engines had been developing significantly less than full wet power. In any event, under normal flying conditions, the aircraft could have safely gone around with the engines trimmed to 60 percent dry power.

Performance calculations, using rates of climb derived from the flight test data for 16.5 degrees of flap and indicated airspeeds as flown at the time of the attempt to go around, indicate that, even with a wind change such as the aircraft encountered, it should have been able to sustain a safe rate of climb at either full wet power or at dry power with a fuel trim setting of 60 percent trim-up. However, if in addition to the wind change, the aircraft had encountered a downdraught of the order of five metres per second while using full wet power, or one of two and a half metres per second while in a 60 percent trim-up power condition, its rate of climb would have been negated.

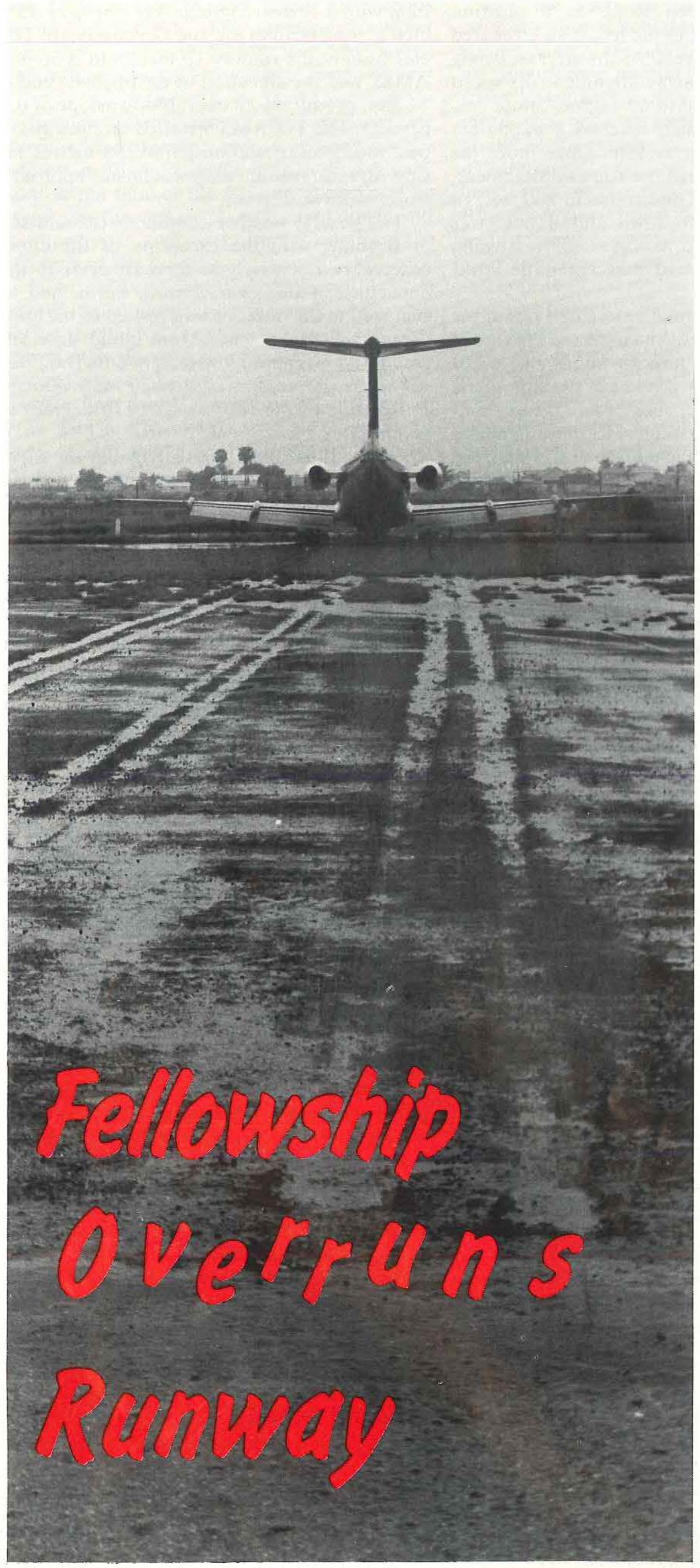
It is estimated that for a weather disturbance to produce a down-flow of five metres per second, cumulus cloud would need to have developed to a height of 20 000 feet. Post analysis of the atmospheric conditions existing at the time indicates that such cloud was possible, and that a horizontal outflow of some 30 knots is not inconsistent with an average downflow of five metres per second over the apparent diameter of this meteorological disturbance. It is possible therefore that the aircraft encountered a downdraught of between five and two and a half metres per second; the relationship between the headwind, downdraught, and tailwind components varying according to the height of the aircraft, its location within the disturbance, and the engine power actually being delivered at the time. Altogether, it is evident that the accident resulted from the fact that, during the attempt to go around, the aircraft's climb performance was adversely affected by an unpredictable encounter with a large change in horizontal wind component associated with a downdraught at a height too low to affect recovery. A factor contributing to the accident was that the landing approach was continued to a very low height in rapidly deteriorating conditions.

Though probably no more than 800 metres in diameter, it is reasonable to assume that the heavy rain and hail associated with the meteorological disturbance could have been discernible on the aircraft's weather radar had it been operating. But the radar, though it was switched to 'Standby' was not operated during this short flight of eight minutes from Orange to Bathurst. The crew had overflown this area only 50 minutes before in good visibility, with no significant cloud, and this was a reasonable decision. Yet with hindsight, it seems that the intensity of the disturbance would have been more apparent to the crew on radar than was evident from the captain's visual assessment, limited as this was by night visibility and the lack of contrasting background.

The sighting of a significant radar return from the disturbance might in fact have conditioned the crew to a more cautious approach, and thus to an earlier decision to go around once adverse conditions were encountered.

A detailed report on the investigation of this accident has been published and is available from the Australian Government Publishing Service, PO Box 28, Canberra, A.C.T., 2600. Its reference title is 'Special Investigation Report 76-2'.

The narrow margin by which the Friendship avoided far more serious damage is evident in this picture.



Fellowship Overruns Runway

While landing at Broome, Western Australia, in conditions of rain and low cloud in the early hours of the morning, a Fokker Fellowship over-ran the length of the runway and became bogged. The aircraft sustained minor damage but none of the sixty-one occupants was injured.

* * * * *

At the time of the incident, the aircraft was operating a regular public transport flight from Perth to Darwin, with intermediate stops at Port Hedland, Broome, Derby, and Kununurra. After an uneventful arrival at Port Hedland, the aircraft departed for Broome at 0240 local time with an ETA of 0322 hours. The terminal forecast for Broome, issued to the crew before departing from Perth, indicated that the wind would be from 290 degrees at eight knots, the visibility 15 kilometres in rain. Some cumulo-nimbus, cumulus and stratus cloud was expected at 1400 to 2000 feet.

Twice during the flight from Port Hedland the current Broome weather report was passed to the aircraft. The reports gave the surface wind as 320 degrees at eight knots, visibility reduced to eight kilometres in rain, and up to three OKTAS of fracto-stratus cloud at 1500 feet. As well, the crew were given the observed wind at 1000 feet as 275 degrees at 10 knots.

Approaching Broome, after negotiating a line of thunderstorms during their descent from cruising level, the crew attempted a DME arrival but subsequently conducted a missed approach after failing to gain visual contact at the minimum altitude of 800 feet. An NDB approach was then made, as a result of which the crew achieved visual reference at 900 feet while approaching the aerodrome on a heading of 216 degrees magnetic. The captain then continued the descent to the minimum circling altitude of 800 feet, by which time the aircraft was on a left downwind leg for runway 10, almost in position to turn base. At this stage the aircraft encountered light rain. The captain did not turn on his windscreen wiper, but the first officer's wiper was operating. Rain repellant was not used.

During its turn on to final approach the aircraft overshot the runway alignment and, at a height of 600-700 feet, the approach was abandoned. The captain then continued a left-hand circuit and manoeuvred the aircraft for an approach to runway 28, the reciprocal of runway 10, but while turning final for 28 the runway lights became obscured by low cloud. When he regained sight of the runway threshold the captain judged that the aircraft was too high and again abandoned his approach at a height of 600-700 feet. Continuing the left-hand orbit of the aerodrome, the captain now manoeuvred on to a left downwind leg for a bad weather circuit to runway 10.

Again the aircraft overshot the runway alignment. At this stage it was flying substantially level, passing from below the normal three-degree approach slope to a position above it, and turning to the left at an estimated bank angle of 35 degrees. As the aircraft swung back towards the runway alignment the speed brakes were deployed to 40 degrees and a descent commenced which reached a maximum rate of 2200 feet per minute. Once more the aircraft passed through the runway alignment, but by the time it had descended to 200 feet, 18 seconds before touch-down and 610 metres short of the threshold, it was virtually aligned with the runway and had intercepted the VASI approach slope.

At this stage the captain increased power for a few seconds, which over-corrected the rate of descent, placing the aircraft above the VASI approach slope, and disarmed the automatic lift dumper circuit. The first officer immediately reset the circuit. For the remaining 10 seconds of flight, the approach was stable in that the aircraft was aligned with the runway and descending at an approach angle of three degrees, but its aiming point was further down the runway than normal.

A firm touch-down was made and full extension of the speed brake was immediately selected. The lift dumpers operated normally, and almost immediately the captain applied firm braking. The deceleration and feel of the brakes, including the anti-skid system, seemed normal, but about 300 metres after touch-down the captain believed that a loss of braking efficiency had occurred. He and the first officer then applied maximum brake pedal pressure but this action seemed to have no additional effect on the aircraft's deceleration. The captain was of the opinion that normal deceleration was again achieved as the aircraft traversed the final 250 metres of the runway. At a speed of just over 30 knots the aircraft over-ran the sealed surface of the runway, traversed the full length of the gravel stopway and entered an area of soft rain-sodden ground. After rolling a further 36 metres, the nose of the aircraft ran through a wire fence, the nose undercarriage entered a depression and the aircraft came to stop in water 15 centimetres deep.

* * * * *

Damage sustained by the aircraft was minor but it was not possible to recover it from its over-run position for several days. The aircraft's brakes were immersed in water for two of these days, and when the aircraft was finally recovered it was found that one of the four wheel-brake assemblies was inoperative. The condition of the tyre did not suggest there had been any long-term malfunction of the brake unit concerned, and it was not possible to tell from examination of the brake assembly if it had been operating when the over-run occurred. Examination of all four main tyres revealed no evidence of tyre deterioration or any other condition indicative of skidding or aquaplaning.

Runway 10/28 at Broome is 1527 metres long with a low-strength gravel stop-way 45.7 metres long beyond the end of runway 10. The elevation of the runway 10 threshold is 56 feet AMSL and the elevation of the opposite end is 22 feet, producing an overall downslope of 0.7 percent. The T-VASIS installed on runway 10, positioned to an aiming point 305 metres inside the threshold, delineates an approach slope of three degrees.

The general weather conditions encountered at Broome, with the exception of the cloud base, were essentially as forecast prior to the departure of the aircraft from Perth, and as reported in the observations passed to the crew during the flight. The actual cloud base encountered was about 900 feet, or some 600 feet lower than forecast. The surface wind velocity at the time of the landing was 270 degrees at seven knots.

Rain had been falling throughout the night at Broome, and had become heavy at about 0135 hours. The heavy rain had then lasted until eight minutes before the aircraft touched down. The rainfall for the two hours preceding the aircraft's arrival was later measured at 52 millimetres.

A company traffic officer had inspected the runway in a motor vehicle about 15 minutes before the aircraft's arrival in the circuit area. While doing so, he had noticed a wide flow of water which he estimated to be two and a half to six centimetres deep covering some 150 metres of runway about 1000 metres in from the runway 10 threshold. As well, particularly on the eastern or lower half of the runway, there were small areas of water up to one and a half centimetres deep. Water was flowing off the runway over its entire length. The water had not impeded the traffic officer's vehicle and its presence was not reported to the crew of the aircraft.

The aircraft's maximum permissible gross weight for landing was 26 761 kg and it was calculated that the landing weight at Broome was 26 346 kg. The centre of gravity was within the permissible limits.

Landing performance information available to the crew indicated that, in calm conditions, a runway length of 1262 metres was required. If landing with a seven knot tailwind component, 1387 metres would be required. The actual effective operational length available for a landing was 1527 metres on runway 10 and 1694 metres on runway 28.

The target threshold speed computed for the landing at Broome was 119 knots, with the desired approach speed 124 knots. Using normal landing technique, touch-down could have been expected at 115 knots.

The Fellowship's flight data recorder indicated that the aircraft crossed the runway threshold at an altitude of approximately 140 feet (a wheel height of about 80 feet), and followed a descent path slightly above, but parallel to the normal three degree approach slope. Throughout the approach, the indicated airspeed varied around 130 knots, but there was an excursion to 139 knots 45 seconds before touch-down. The airspeed recorded over the runway threshold was 131 knots, which decreased to 115 knots at touch-down.

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In view of the surface wind forecast for Broome, the weather reports passed to the aircraft in flight, and the actual wind conditions at the time of the landing, it needs to be asked why the captain chose to land downwind on runway 10, and what effect this had on the outcome of the landing.

It is unlikely that the crew could have sighted the illuminated wind-sock while preparing to land but the captain said he had been informed on the company frequency at Broome that the wind was calm. In any case there is no specific operational limitation to landing an F-28 with a tailwind component of up to 10 knots, and it might be significant that neither the forecast surface wind nor any of the observations received whilst en route reported a surface wind in excess of 10 knots. For the conditions of the landing, including the seven knot tailwind component, the runway length required was 1387 metres, 140 metres less than the length available. Thus, in isolation, the existing wind velocity did not preclude a landing on runway 10.

Though the cloud base at Broome was lower than forecast, it still permitted an instrument approach to the minimum night altitude of 800 feet. The first and second landing approaches were abandoned because of difficulty in positioning the aircraft. The third attempt was then initially unstable in that the aircraft twice overshot the runway alignment while being manoeuvred on to final approach and at the same time reached a point substantially above the three degree approach slope delineated by the T-VASIS. To correct this, a rate of descent of 2200 feet per minute was established. By contrast, the operator prescribes a maximum descent rate of 1000 feet per minute when the aircraft is less than 1500 feet above the ground.

For the final 10 seconds of flight, the aircraft's approach had been stabilised but the aiming point of the approach was further down the runway than normal and the airspeed some seven knots higher than desired. This excess speed was not corrected as the aircraft approached the threshold.

Although the crew were not specifically advised that heavy rain had been falling at Broome for two hours before the landing, the weather reports passed to them in flight were each indicative of moderate to heavy rain. By the time the aircraft became visual in the circuit area however, the rain had abated to light and, as the results of the runway inspection were not passed to the crew, they might not have been aware that there was water on the runway. Nevertheless, from the information available to them it would have been obvious that they were landing on a runway which was at least thoroughly wet.

Despite the crew's impressions to the contrary, analysis of the flight data record from the point of touch-down throughout the landing roll indicated that the aircraft's rate of deceleration was sustained and uniform, and close to the rate normally achieved. This was supported by the fact that the aircraft's tyres showed no evidence of aquaplaning, nor were any marks characteristic of aquaplaning found on the runway.

One of the premises on which the 'required runway length' is based is that the aircraft will cross the threshold at a wheel height of 50 feet and at a speed equal to 1.3 times the power-off stalling speed (1.3 Vs). This will produce a touch-down 305-457 metres beyond the threshold but in this case the aircraft overflew the normal touch-down zone by 176 metres. The runway length available was only 140 metres in excess of that required, so that if all other tolerances incorporated in the 'required runway length' were utilised to their maximum limits, it could be expected that the aircraft would have overrun the available distance by

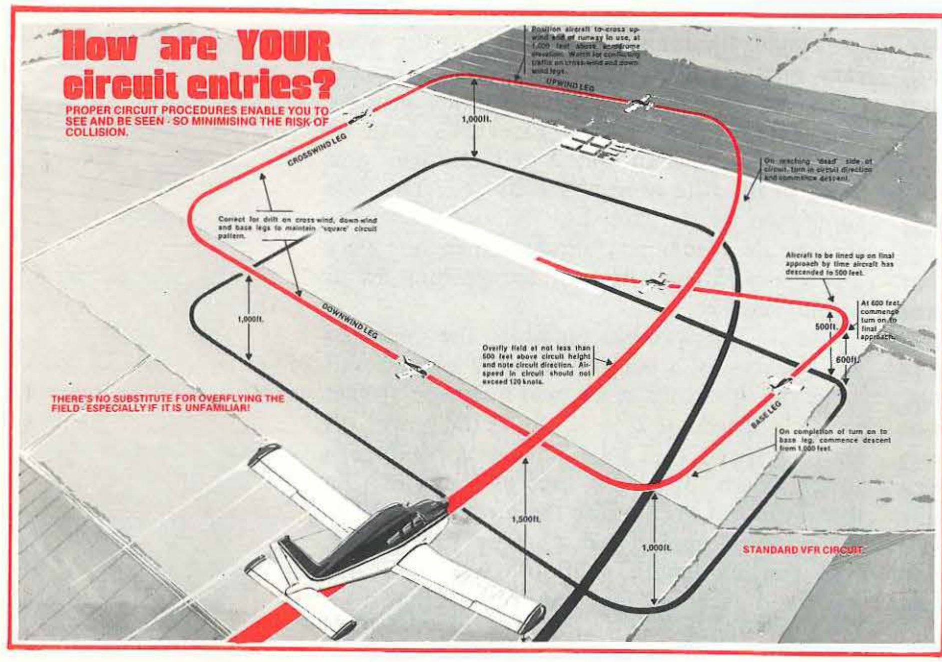
The flooded area in which the Fellowship came to rest. The aircraft was in the process of being recovered when this picture was taken.

36 metres. Nevertheless, it is considered that the touch-down point alone was not an exclusive factor. Rather, in this incident, there was an accumulation of factors, each requiring additional runway length, and each placing the aircraft near the maximum limit of the safety margins allowed. For example, if the effect of one brake being inoperative is introduced, then the aircraft came to rest only 94.5 metres beyond the landing distance required.

Part of the problem which led to the landing approach being initially unstable was undoubtedly the fact that the tail wind component had not been recognised or compensated for by the crew. Their earlier difficulties in positioning the aircraft for an approach to runway 10, together with the wind information which had been provided to them a number of times, should have alerted the crew to the need for care in establishing a correct and stable approach to this wet runway.

It has not been possible to precisely determine the effects of each variation from optimum procedure on runway distance, but it is considered that the 'landing distance required' was exceeded by 222 metres, because of the cumulative erosion of the safety factors applied to the various areas of aircraft landing performance. This was possibly compounded by one of the four wheel brakes being inoperative during the landing. Nevertheless, a major factor in the initiation of this chain of events, was that the pilot-in-command persisted with the landing from an unstable approach.

A detailed report on the investigation of this incident has been published, and is available from the Australian Government Publishing Service, PO Box 28, Canberra, A.C.T. 2600. Its reference title is 'Special Investigation Report 75-1'.



CIRCUIT AREA PROCEDURES

From comments we have received, some readers have interpreted the standard circuit area diagram in the centre-spread of Aviation Safety Digest No. 97 as a mandatory requirement for all non-controlled aerodromes.

Like other safety education information published in the Digest however, the diagram is purely advisory, reflecting good operational practice taught by flying schools. Heights and speeds set out in the diagram, while mandatory for aerodromes in secondary control zones, are not a requirement at non-controlled aerodromes and may be varied according to circumstances and aircraft operational considerations.

The operating characteristics of some aircraft, particularly larger and higher performance types, are often incompatible with the procedures in common use by light aircraft pilots. For this reason, it is not possible to specify precise circuit procedures for non-controlled aerodromes that are suitable for all aircraft types.

In secondary control zones, aircraft may enter the circuit by overflying at 1500 feet QNH or they may enter at circuit height, remaining outside the traffic pattern until the upwind, crosswind or downwind leg of the circuit can be joined. Unless otherwise authorised by ATC, pilots are required to fly at least three legs of the circuit, and be established on the downwind leg at circuit height before passing the upwind end of the runway in use. All turns made in secondary control zones must of course be made in the circuit direction.

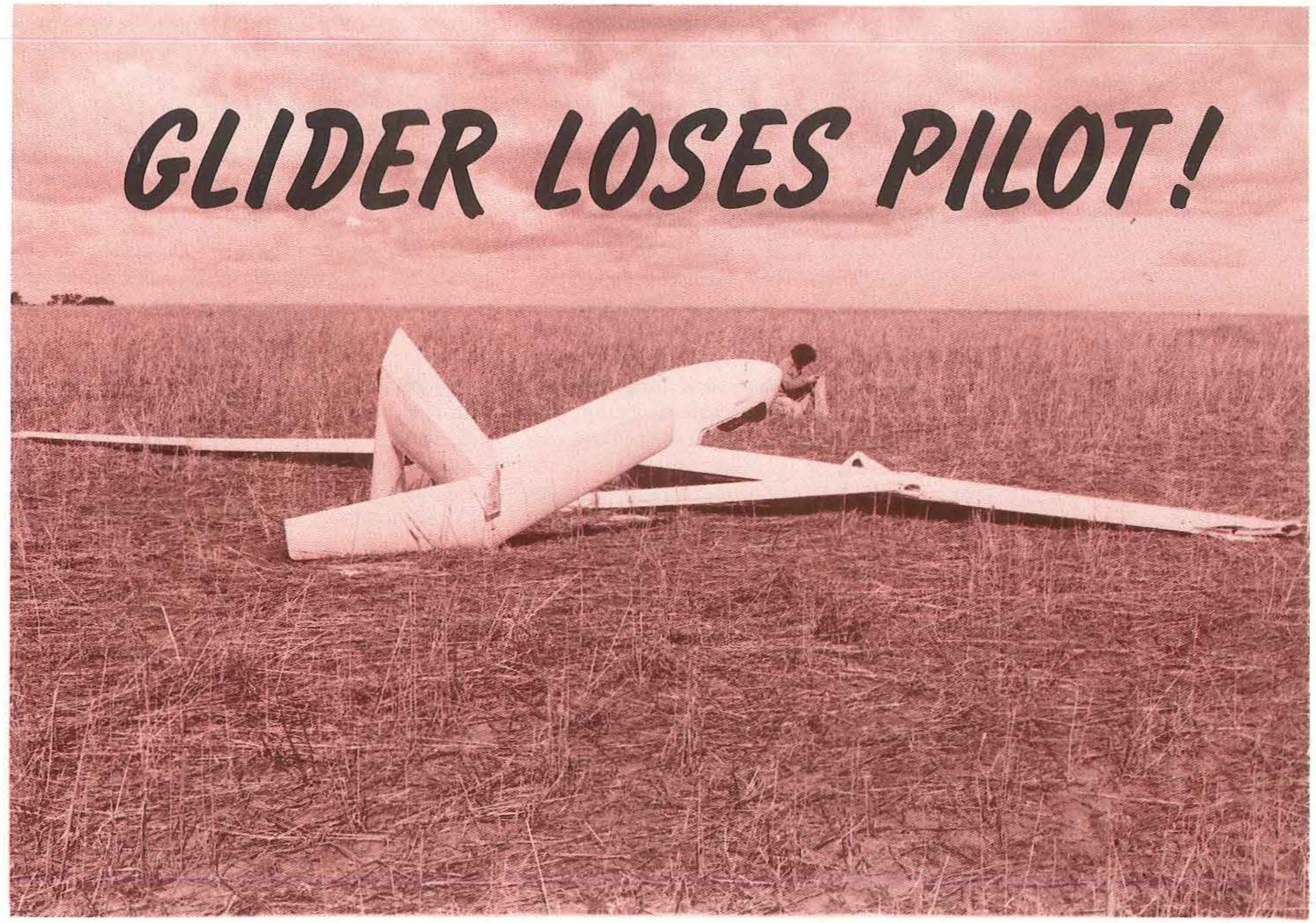
At non-controlled aerodromes, aircraft may overfly or join the circuit on the upwind, crosswind or downwind legs and may make a right turn to join a left downwind, or vice versa.

When conditions are less than VMC at a non-controlled aerodrome, IFR aircraft which have completed an instrument approach or a DME arrival are permitted to make a straight-in approach or to enter final from a left or right base. In situations where the weather at a non-controlled aerodrome is fluctuating about the VMC minima, therefore, the adoption of these procedures could conflict with those being flown by VFR aircraft. In these circumstances, increased vigilance for other traffic by both IFR and VFR pilots is particularly necessary.

Irrespective of the alternative circuit joining procedures permitted for VFR aircraft, it is considered sound operational practice to overfly, especially if the pilot is unfamiliar with the aerodrome.

All these procedures are set out in detail in both VFG and AIP.

GLIDER LOSES PILOT!



The pilot of a Standard Cirrus glider, flying at about 3000 feet south of Waikerie aerodrome, was adjusting the glider's electronic variometer-computer when he dropped a small screwdriver.

With his safety harness loosened, his attempts to retrieve the screwdriver from underneath his seat were unsuccessful. The pilot therefore trimmed the glider for straight and level flight at 45 knots, undid the harness and after searching for about five seconds, picked up the screwdriver from the floor just forward of the cockpit rear bulkhead.

The pilot then sat back in his seat and using both hands started to refasten the harness. He had the lower left strap in place and the two shoulder straps on the pin and, with the lower right strap in his other hand, was about to complete the connection when turbulence deflected the port wing up and the nose suddenly pitched down.

Trying desperately to hold the harness together against the negative 'g', the pilot caught a fleeting glimpse of articles from the glider's side pockets rising and collecting against the canopy. Then he lost his grip on the harness and the next moment found himself being hurled into space through the glider's canopy.

The pilot was wearing a Slimpak parachute and, as he fell clear, he began searching for the D-ring. At first he looked in the wrong place and it was only after he had fallen for a few seconds that he realised his mistake and was finally able to grasp the D-ring and pull it. At about 700 feet, with the parachute now fully deployed, he looked up to see the glider circling overhead in an inverted turn. The glider circled him once more before crashing upside down. The pilot landed within 10 metres of the wrecked glider — without the parachute's D-ring but still clutching the offending screwdriver!

* * * * *

This accident spotlights the potential danger of undoing a safety harness in flight, and its lesson applies just as much to light aircraft pilots as to glider pilots. Even loosening a safety harness can be hazardous for, in unexpected turbulence, a pilot could be seriously hurt or even knocked unconscious if he hit his head on the cabin roof.

In this instance, the pilot was certainly faced with a dilemma. He had a loose article in the cockpit — a screwdriver — quite capable of jamming the control linkage, and he was understandably anxious to retrieve it. However, as this accident proves, a lone pilot with his safety harness undone is in an extremely vulnerable situation.

The circumstances of the accident also contain another important safety lesson — the obvious need for pilots to be familiar with their emergency equipment to the point where its operation virtually becomes a reflex action and does not require time to stop and think.

This philosophy of course applies to all emergency situations, but probably nowhere is it more critical than when using a parachute. In this accident, the time the pilot spent looking for the D-ring — though only a few moments — could well have proved fatal had the upset happened only a few hundred feet lower.

As it turned out, though damage to the Cirrus glider was extensive, it was less than it might have been in an accident of this sort and the glider was subsequently repaired. The other consequences seem to have been confined to the pilot's pride!

PLANNING FOR DISASTER

Careful and thorough flight preparation, and the constant monitoring of in-flight progress, are vital to the safe operation of any aircraft. Yet, as we have seen so many times before, they also tend to be among the most neglected of a pilot's responsibilities! Flight planning often seems to be regarded (and not always by the inexperienced) as so much unnecessary formality to be got through with an absolute minimum of effort before one can set off on the flight itself. In the air, any carelessness in checking flight progress can have disastrous consequences. Just how true this can be is well illustrated in an accident that occurred recently in South Australia.

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A pilot was to conduct a charter flight for a charter and flying training organisation based in South Australia. The pilot, who was 26, had gained his commercial licence only nine weeks before, and this was his first long-distance charter, a sight-seeing tour carrying two passengers from Casterton, Victoria, to Ayers Rock in the Northern Territory.

The aircraft to be used, a Cessna 182, was based at Mount Gambier and the pilot arrived at the aerodrome early in the morning to prepare for the flight. He completed a flight plan showing he would be operating VFR below 5000 feet, using full position reporting procedures. The aircraft's fuel tanks had been filled to capacity, and the pilot gave its total endurance on the flight plan as 360 minutes. The estimated time interval between Mt. Gambier and Leigh Creek, where he planned to refuel, was shown as 254 minutes.

At 0848 hours Central Standard Time, the pilot took off from Mt. Gambier, arriving at Casterton to pick up his passengers 15 minutes later. The aircraft finally departed for Leigh Creek at 0920 hours.

At first, the pilot climbed to 2500 feet and, levelling off below cloud, he leaned the mixture using the aircraft's exhaust gas temperature gauge. After he passed Lameroo, the cloud base lifted and, without increasing power, he climbed to 3500 feet where he adjusted the mixture setting again.

On reaching Waikerie, his next reporting point, he discovered he was losing time, even though he was on track. Later, at 1240 hours, when he reported abeam Yunta, he was 37 minutes behind his flight-planned estimate for this position. By this time, both the aircraft's fuel gauges were reading between a quarter and a half full but, though the pilot began to be concerned that his fuel consumption was greater than planned, he still believed he had sufficient fuel to reach Leigh Creek.

The pilot next reported at 1340 hours over Oraparinna homestead in the Flinders Ranges, some 57 nautical miles south of Leigh Creek. By now, the aircraft was 49 minutes behind its flight plan ETA, and the fuel gauges were each showing less than a quarter full. In fact just before reaching Oraparinna, the pilot had selected the starboard fuel tank with the intention of running it dry. Yet despite his increasing anxiety over the aircraft's fuel state, the pilot gave no indication in his position report that the operation was other than normal.

Not long after passing Oraparinna, the engine misfired, indicating the starboard tank was dry, and the pilot selected the port tank. After a few minutes he momentarily reselected the starboard tank again, to ensure it was empty, then switched back to the port tank.

Only at this stage, with the aircraft well into the rugged and inhospitable terrain of the Flinders Ranges, did the pilot accept he would not be able to reach Leigh Creek. Soon afterwards, he caught sight of a homestead and called Leigh Creek to advise that he suspected fuel starvation and that he would be making a precautionary landing near the homestead. He also requested that his SARWATCH be cancelled. Instead, the flight service officer on duty declared the Alert Phase of search and rescue procedures, and asked the pilot to report after landing.

Deciding he would have to put the aircraft down on the access road to the homestead, the pilot began a descent. He then saw the terrain was not as good as it had appeared at altitude and that his intended landing area was in reality a rough, narrow track. Believing he now had no choice but to continue the approach, he selected the straightest stretch of track, made an approach and touched down. But as he was doing so, he saw the surface was totally unsuitable and applied power. Further along the track he made another attempt to land but again found it impossible. As he was going around from this second attempt, during a climbing turn to port, the engine misfired once, then stopped.

At this stage the aircraft was only 250 feet above rough, undulating ground and the pilot was faced with an immediate forced landing. Continuing the turn to align the aircraft into wind, the pilot touched down on stony, rising ground at an oblique angle to a low ridge. Almost immediately the aircraft struck an outcrop of rock, the nose dug in, and the aircraft somersaulted on to its back and came to a stop, damaged beyond repair.

The three occupants suffered only minor injuries, and were able to vacate the aircraft quickly. The pilot's ankles had been bruised however, making it painful for him to walk, so both passengers went off to summon help from the nearby homestead.

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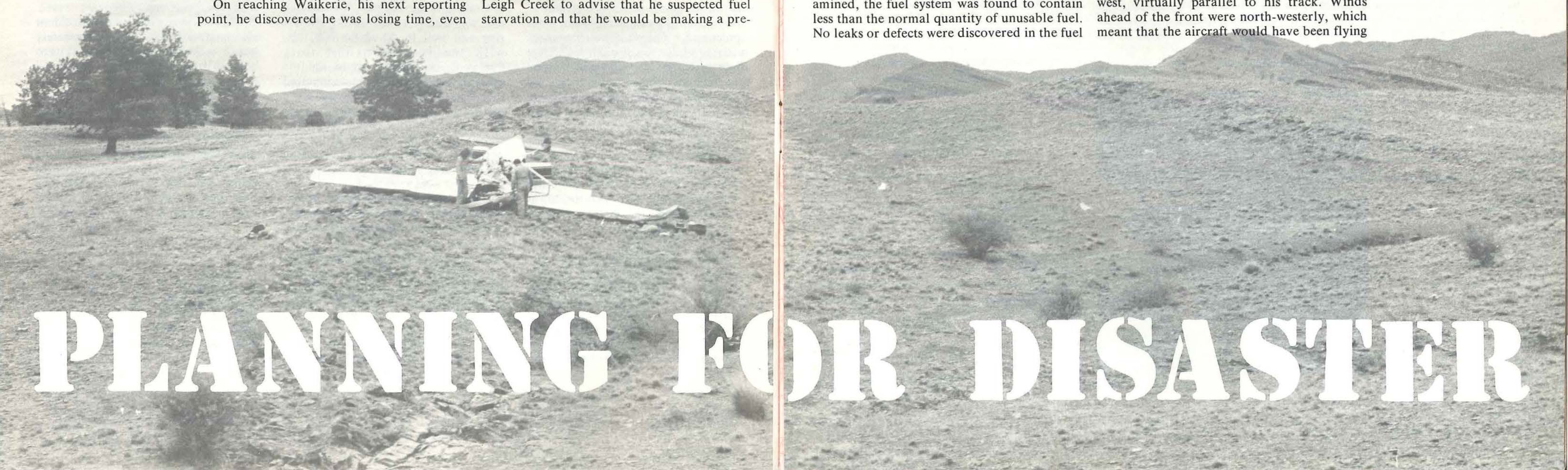
When the wreckage of the aircraft was examined, the fuel system was found to contain less than the normal quantity of unusable fuel. No leaks or defects were discovered in the fuel system, and all tests indicated that the engine had stopped because of fuel exhaustion.

The flight plan was checked and was found to contain numerous errors and inconsistencies. The pilot said he had planned the flight using a fuel consumption rate of 50 litres per hour, the figure used by the operator. The total endurance of 360 minutes shown on the flight plan was indeed correct for this rate and the aircraft's usable fuel capacity of 300 litres. But his other fuel requirement calculations for cruise, and for fixed and variable reserves, were confused and inaccurate. On the flight plan, he had shown endurance in terms of both time intervals and fuel quantities but when his calculations were checked, it was found he had used consumption rates which appeared to vary randomly between 43 and 57.5 litres per hour.

During the subsequent technical examination of the engine instruments, it was found that, while the manifold pressure gauge was accurate, the tachometer was under-reading. At 2350 RPM, the cruise setting used on the flight, the actual RPM would have been 2440. The total flight time before the fuel was exhausted was 308 minutes. Using this time interval and taking into account the fuel used during the take-offs and climbs, it was calculated that the fuel consumption rate actually achieved in cruising flight was 56 litres per hour. This was slightly more than the figure of 53 litres per hour which can be calculated from the aircraft owner's manual for the cruising altitude and actual engine power used, and higher again than the 50 litres per hour the pilot had used in his endurance calculations.

Quite apart from the fuel calculations however, there were significant errors in the pilot's basic flight planning. The relevant area forecasts indicated that a cold front lay to the west, virtually parallel to his track. Winds ahead of the front were north-westerly, which meant that the aircraft would have been flying



directly into a 30 knot headwind. Behind the front, the wind was blowing at about right angles to the aircraft's track, and might even have produced a very small tail-wind component. The front was moving east but, from the information contained in the forecasts, it should have been apparent to the pilot that the front would still have been to the west of his track at the time he expected to reach Leigh Creek. Yet the pilot planned most of the flight using the winds as forecast for **behind** the front though, of course, his actual flight conditions were those that existed **ahead** of the front. Had the pilot used the correct winds, the planned time interval to Leigh Creek would have been about 307 minutes at an average ground speed of 95 knots — a figure close to the speed actually achieved by the aircraft en route. Based on this estimated time interval, even at the optimistic fuel consumption rate of 50 litres per hour which the pilot used to calculate the aircraft's total endurance, the quantity of fuel required, including fixed and variable reserves, would have been 337 litres, some 37 litres more than the aircraft's total fuel capacity!

The pilot's errors did not cease once the aircraft left the ground. At first, the aircraft maintained its flight planned time intervals reasonably closely but, after it had been in the air about two and a half hours, the pilot realised he was considerably behind time and calculated his ground speed to be only 85 knots. Another check a short time later showed it to be about 100 knots, but it was not until he reached Yunta, still some 140 miles short of his destination, that he began to be concerned about the apparent high rate of fuel consumption. Yet, instead of using an accurate groundspeed to calculate a revised time interval for the remainder of the flight, the pilot decided solely on the basis of comparing the elapsed flight time with his planned endurance, that he had sufficient fuel to continue to his destination. Had he calculated a new ETA it would have been obvious that he could not possibly reach Leigh Creek and that an immediate diversion for fuel was essential. Port Pirie aerodrome, clearly marked on the World Aeronautical Chart, lay only 70 nautical miles to the west and at that stage was within the aircraft's range.

The rock-strewn nature of the terrain and the severe damage to the aircraft are evident in this picture.

Despite his misgivings, the pilot apparently did not consider deviating from his flight planned track and instead continued on over the remote, higher ridges of the Flinders Ranges. At no stage did he communicate his concern about the low fuel state to Leigh Creek, even when the starboard tank ran dry. Had he done so, there were several airstrips in the vicinity to which he could have been given directions. In 'pressing on', it seems that the pilot had a great reluctance to accept that the situation was becoming critical. For even if he had simply maintained altitude and headed west only five to eight nautical miles, the aircraft would have been clear of the ranges and over flat, open country far more suitable for a precautionary or forced landing. As it was, when all fuel was finally exhausted, luck alone was on the pilot's side and although the aircraft was 'written off', the consequences so far as the occupants were concerned were far less severe than they could have been.

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Certainly, in planning this flight, the pilot made significant errors both in his fuel calculations and in the application of wind effect. Yet those errors, serious in themselves, need not have resulted in an accident at all had the pilot properly monitored the operation of the aircraft as the flight progressed.

Despite the most meticulous pre-flight preparation, a flight will rarely proceed exactly as planned. Depending on the type of exercise being conducted, the rate of fuel consumption in any aircraft can vary over a wide range. Similarly, a pilot would be fortunate indeed if the winds encountered on a long navigational flight were precisely as forecast. In this particular instance, the aircraft's lower than normal ground speed and the diminishing fuel reserves were obvious in flight and were recognised by the pilot. But these warning signs went unheeded and, by the time it should have been obvious that the aircraft could not possibly have reached its planned destination, it was too late to divert to a suitable aerodrome for fuel.

Sound planning and the application of established principles will generally more than provide for the great variety of conditions and circumstances constantly encountered in operating an aircraft. By being prepared for such contingencies, a pilot should be able to take timely action to avoid an accident, rather than hopefully persisting with a situation to the point where a safe alternative course of action is no longer possible.

DRIVEN TO DISTRACTION?

The consequences of interruptions during vital checks and drills have been discussed many times in past issues of the Digest, and are recognised by most pilots. Yet no matter how careful or experienced a pilot might be, it is only too easy to fall victim to this most insidious of hazards. Another variation on this familiar theme is described in the following contribution from the captain of a jet airliner operating an international passenger flight.

* * * * *

We had been cleared for a VOR/ILS approach into an overseas airport. Because of mountainous terrain nearby, the published jet procedure for the runway in use required the aircraft to make an initial approach at 7000 feet. It was then to track outbound on a specified VOR radial while descending to 2700 feet, and finally turn through 180 degrees to intercept the ILS. Radio-navigation aids associated with the ILS included two locators, marker beacons, and a missed-approach locator aligned with the extended runway centre line, and situated some one and a half miles from the airport. The locators transmitted their identification codes every 12 seconds and the ILS was Category 1, with a minimum altitude of 200 feet.

We commenced the approach in IMC, with the tower controller reporting moderate to heavy rain and a visibility of 2000 metres. At 10 DME we intercepted the localiser and, as the glide slope needle came alive, the undercarriage was selected down. Both the first officer and I checked that we had 'three greens' and, as we intercepted the glide slope, full flap was also selected and the speed stabilised at 120 knots.

After we had passed the outer locator, the first officer re-selected one ADF to the missed approach locator, and spent a few seconds attempting to identify it aurally. About this time, the tower controller passed additional weather information to us, his transmission momentarily drowning out the rather weak locator signal.

At 1200 feet on the approach, we encountered heavy rain and I switched the windscreen wipers to high speed. A few seconds later, the rain ceased and the wipers began scraping dry glass. Because of strong drift from the right, I was concentrating all my attention on tracking the localiser centre line and I asked the first officer to turn off my wiper switch, as on the captain's side it is in an awkward position to operate.

As we descended through 900 feet, we again entered moderate to heavy rain, and I called for wipers on again, as well as rain repellent. Just at this moment, the tower controller began to talk loudly about the wind strength and direction — reading out these figures every 15 seconds or so. I was about to tell the first officer to get final landing clearance as quickly as possible, when the controller began to issue lengthy missed approach instructions (which in any case were the same as those on the ILS approach chart), and concluded with a clearance to land, shortly before we reached 300 feet — still in IMC! At the minimum altitude however, we sighted the runway end indicator lights and completed the landing, though still in quite heavy rain.

As we slowed to taxi-ing speed, I took the customary deep breath and asked the first officer to read the after-landing checklist. There was a moment's silence, and then he replied: 'You won't believe this, but guess what we have forgotten to do?' I thought for a few moments and mentioned something about possibly having forgotten the Customs papers. The first officer said: 'No — but we didn't do the **before** landing checklist!' and there, upright on the coaming, was the before-landing slide checklist with all items — including undercarriage, hydraulics, lift dumpers — still uncovered . . .

Fortunately, our company uses the 'scan' method of cockpit checks which means that the necessary vital actions are carried out as required and then confirmed by reference to the slide check list. As it is standard company procedure to lower the undercarriage at the point where the glide slope needle comes alive, then to select full flap as the glide slope itself is intercepted, we had actually done all the drills correctly, but had not confirmed them by using the checklist.

In retrospect, I believe our omission to use the checklist was caused by a series of distractions — none of which in themselves were sufficient to cause this sort of problem but, when added together, were enough to result in even an experienced crew being caught out. Perhaps the main distractions were the controller transmitting too much information at a critical stage of the approach, and then adding a request for us to call when approaching the middle marker for final landing clearance.

It is surprising how often unwanted radio calls on busy airways interfere with communication between the crew. In order to pass instructions to other crew members, pilots are forced either to quickly lower volume levels, or even to momentarily switch off a receiver — and most of us know how embarrassing it can be to forget to turn it back on again!

Some military aircraft I have flown are fitted with a spring loaded radio muting switch that can be used to provide a 'breathing space' in background chatter in order to carry out vital cockpit challenge-response drills. I believe these switches are an important safety feature and feel that, in the circumstances of this particular incident, a facility of this sort would have helped avoid a potentially dangerous situation.

COMMENT

We thank the pilot for his frank and informative contribution. In regard to the switching off of a radio receiver in these circumstances, the Departmental philosophy is that communication capability must be maintained at all times.

'WE'VE HAD A CRASH ON THE MOUNTAIN'

It was early on a Saturday morning. A Beech Baron, on an IFR charter flight from Sydney to Grafton, NSW, had just broken out on top of dense cloud and levelled off at 9000 feet. Beneath the aircraft the cloud now formed an unbroken sea of white to the horizon.

Although radio transmissions from Sydney Flight Service and from other aircraft were being received at a normal level, the co-pilot suddenly reached forward and turned up the volume of the radio receiver to full. Immediately, a voice came from the speaker, calling rapidly: 'Mayday Mayday Mayday!' Then silence. After checking with his co-pilot that he had heard the message correctly, the pilot in command picked up the microphone and asked the aircraft in distress to identify itself. There was no reply. Concerned, the pilot called Sydney Flight Service and asked if they had monitored the call.

Sydney had not heard the call, nor had any other aircraft listening. However, Sydney began calling all aircraft known to be in the area where the Baron picked up the call, asking each one to confirm that its operations were normal. All the aircraft replied — except one.

The missing aircraft was a PA28 that had left Scone on a flight to Mount Isa via Charleville about twenty minutes before. After trying unsuccessfully for some minutes to contact this aircraft or to determine its position, Sydney Flight Service declared an Uncertainty Phase.

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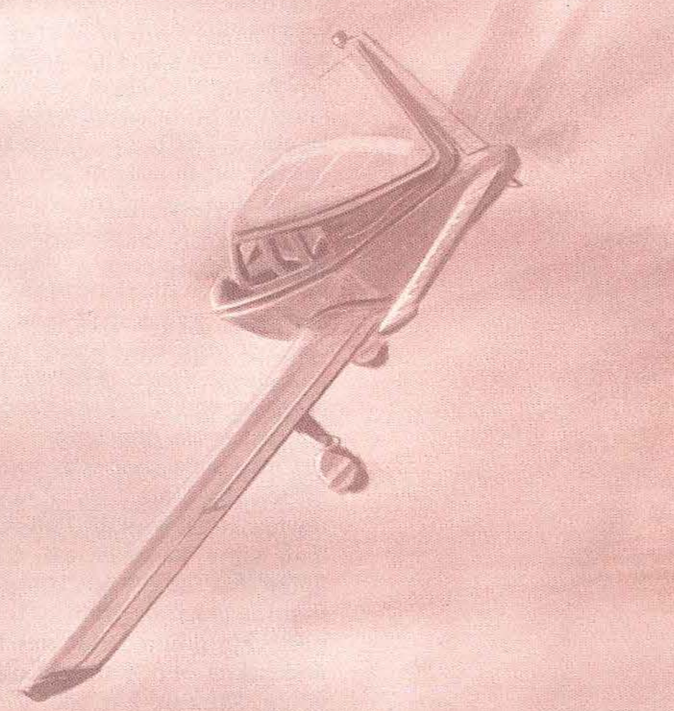
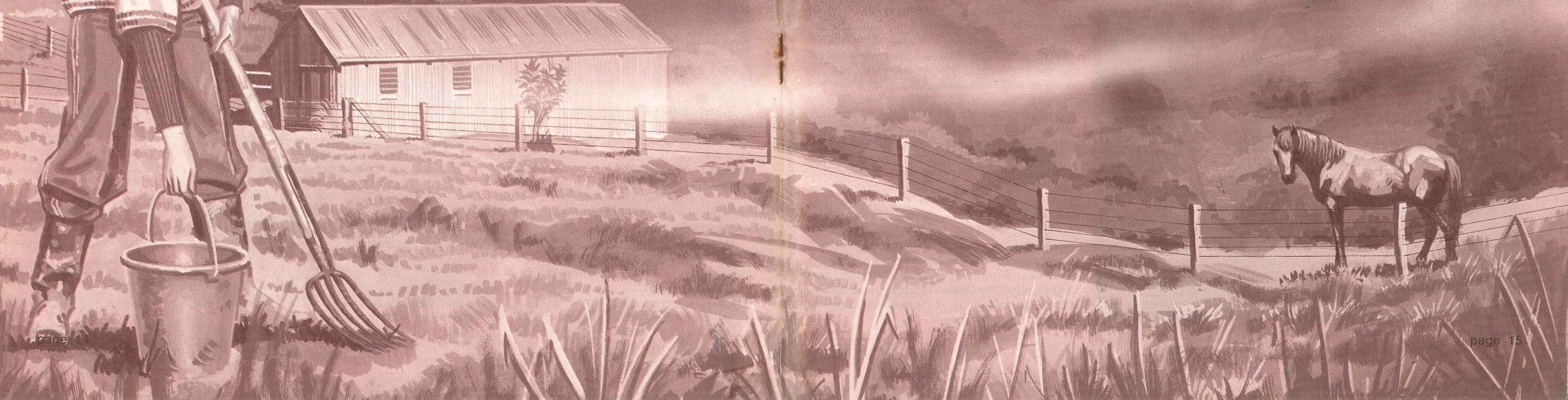
The pilot of the PA28 was a professional engineer, whose business was in Newcastle. Some time prior to the flight, he had, in his professional capacity, been in contact with a mining company based at Mount Isa. The company had discussed with him their urgent need for some mechanical parts, which were essential to their operation. These parts were drum scrubber wheels, large solid rubber wheels on a heavy metal hub, measuring about half a metre in diameter. The engineer had arranged to have the wheels manufactured in Newcastle, and because of the urgent need for them, had offered to fly them to Mount Isa himself. He held a private pilot licence, and had gained about 200 hours experience. He also saw the delivery flight as an opportunity to take his wife and their two young children for a trip.

For the flight the pilot arranged to hire a PA28. At the time, though usually based at Cessnock, the aircraft was at Scone aerodrome. The pilot had originally intended to take the wheels to Scone by car, load them into the aircraft, and then fly back to Cessnock to pick up his family before departing for Mount Isa. However, he was advised by the local flying school to proceed to Mount Isa directly from Scone, so as to avoid any doubtful weather along the coast. The weather in the area had in fact, been cloudy and rainy for about a week.

The pilot had taken delivery of the three drum scrubber wheels the day before the flight, and he and a friend then drove to Cessnock to pick up the aircraft's flight manual to check its load capacity. The drum scrubber wheels each weighed over sixty kilograms, and the pilot was apparently concerned about the aircraft's capability to carry the load with his family on board. On checking the manual and making some calculations, the pilot satisfied himself that the aircraft, when loaded, would not exceed its maximum take-off weight, though it would be near it. Later that day, he rang the Bankstown meteorological office to arrange for a forecast to be available to him at 0400 hours the following morning.

Early next morning, as arranged, the pilot rang Bankstown for the forecast. The forecast predicted broken stratus cloud with a base at 1500 feet, and broken cumulus with a base of 2000 feet in the area south of the Liverpool





Range, but that beyond this range, the weather should markedly improve. The Liverpool Range lies some 15 nautical miles north of Scone, rising in places to over 4000 feet and if the weather was as forecast there would be no chance of finding a pass through the range. The pilot therefore planned to track westwards to Coolah, and from there north-west to Coonabarabran. Once past Coolah, the weather was expected to be good.

The pilot's friend drove the pilot and his family to Scone aerodrome, where they arrived at about 0630. The three heavy wheels were loaded on board the aircraft first. The pilot found that two of the wheels could be stowed behind the front seats, lodged on the floor, without needing any restraint. The third wheel he placed on the floor of the rear baggage compartment, and lashed it to the underframe of the rear seat using nylon tie-down ropes. This was made more difficult because the drum scrubber wheel did not have any holes through which to pass the ropes.

Once the wheels were loaded, the pilot went off to submit his flight plan by telephone, leaving his friend with the family. The pilot's friend had some aeronautical experience, and he noted that the sky was completely overcast and that the general visibility in the area was quite poor. He pointed this out to the pilot's wife, and asked her if she thought they should be going. She told him that it would be all right, as they had flown before in worse weather.

The pilot returned from the telephone and the family climbed aboard the aircraft. The pilot seated his six-year old daughter in the seat behind her mother, and his nine-year old son in the seat behind him. The aircraft started normally, taxied out, and after a fairly long run-up, took off at about 0710.

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At about 0730 hours that morning a farmer and his wife were having their early morning cup of tea at their homestead at Kars Springs, on the southern slopes of the Liverpool Range, when they heard the sound of an aircraft going overhead. The aircraft sounded so low that the farmer's wife went to the kitchen window to look. She could see the aircraft circling, with its rotating beacon on. It seemed very low to her, lower in fact than some of the nearby trees. Even so, it was very hard to see, because it kept moving in and out of low-lying clouds. Finally, she lost sight of it altogether. A short time later, there was a sound like an explosion. Alarmed, she called to her husband that the aeroplane had crashed. The farmer went out and looked up the valley. Only the bottom of the valley was clear of cloud and he was unable to see anything. Immediately he called the police and told his son to get out the horses.

Soon afterwards the farmer and his son, with two neighbours, set off on horseback to try to locate the crashed aircraft. For most of the morning, they searched the eastern slopes of the valley.

Meanwhile, Sydney Flight Service, having received the report of a crash at Kars Springs, had upgraded the Uncertainty Phase that had been declared earlier to the Distress Phase. A number of local aircraft were alerted to look for the missing PA28.

During the course of his search of the mountain slopes, the farmer became separated from his companions. It had been very difficult for him to keep track of the others all the morning, as the cloud was limiting visibility to less than 50 metres. However, rather than turn back to find them, he decided to go on alone into a small valley he was approaching. Half an hour later, about a mile further into this valley, he was astonished to see two young children, a boy and a little girl, walking through the long grass. He did not at first connect them with the aircraft, but as he approached, the boy called out to him: 'We've had a crash on the mountain'.

The two children were wet and bedraggled. The boy was wearing only socks, and the little girl had also lost one of her shoes. Otherwise, they appeared unharmed. Amazed, the farmer questioned them further. The boy told him that their father was dead, and that their mother was trapped under a wheel in the aircraft, crying out for help. They had tried to move the wheel to free their mother, but it had been too heavy. When they had heard an aircraft overhead, their mother told them to go off to try to find help. They had been walking for some hours before they were found by the farmer.

The farmer led the children down the valley to a road, where they met up with the police, and he handed the children over to them.

Later that day at 1425 hours when the cloud had lifted to some degree, one of the search aircraft, flying in very difficult conditions, spotted the wreckage of the PA28. It took the ground party another two hours to reach the crash site. When they did so, they found that the pilot had been killed instantly, and that his wife had died some time after telling the children to go for help.

The hillside on which the Cherokee crashed, looking back along the approach path. The swathe which the aircraft cut through the foliage is in the centre of the picture.

It is impossible to know exactly what happened on the flight of the PA28, but we can reconstruct the events as they probably happened.

At the time of the aircraft's take-off from Scone, there was extensive low cloud in the area and visibility was poor — prompting the friend of the family, who had driven them to the aerodrome, to comment on the adverse conditions to the pilot's wife. In fact another pilot of considerable experience who had intended to leave Scone for Williamtown about the same time, had postponed his flight because of the unfavourable weather.

Once airborne it is likely that the pilot of the PA28 would have found map reading difficult in the poor visibility and it is possible that he mistook a road leading up into the mountains for one he intended to follow around them to the west towards Coolah. It is difficult otherwise to account for the fact that when the aircraft crashed it was about seven nautical miles off track to starboard after travelling a distance of only fifteen nautical miles. The course flown took the aircraft directly towards the high country of the Liverpool Range. Once the aircraft entered one of the blind valleys in this area of the cloud-shrouded range, it was in a situation from which there was virtually no safe way out.

The two young children, having come through such a traumatic experience, could obviously not be questioned too closely but it was learnt from them that, for the last few minutes of the flight, there had been 'fog' all around the aircraft and that their father had made a frantic Mayday call only a few seconds before impact.

Regrettably, it seems that this tragedy was another case of pressing on in adverse weather, entering cloud, and then being unable to keep clear of rising terrain. Yet this pilot had been regarded by his friends and by his flying instructor as being capable, careful and thorough, and it is hard to understand why he would have subjected his family to the risk of flying in such difficult conditions. However, two factors may have influenced his actions. Firstly, the weather beyond the Liverpool Range was forecast to improve markedly, and the pilot might have felt that the risk he was taking to reach this good weather was a low one. Secondly, the urgency of the need to deliver the drum scrubber wheels required by the mining company might have caused him to persist with the flight when, in other circumstances, he might have been more cautious.

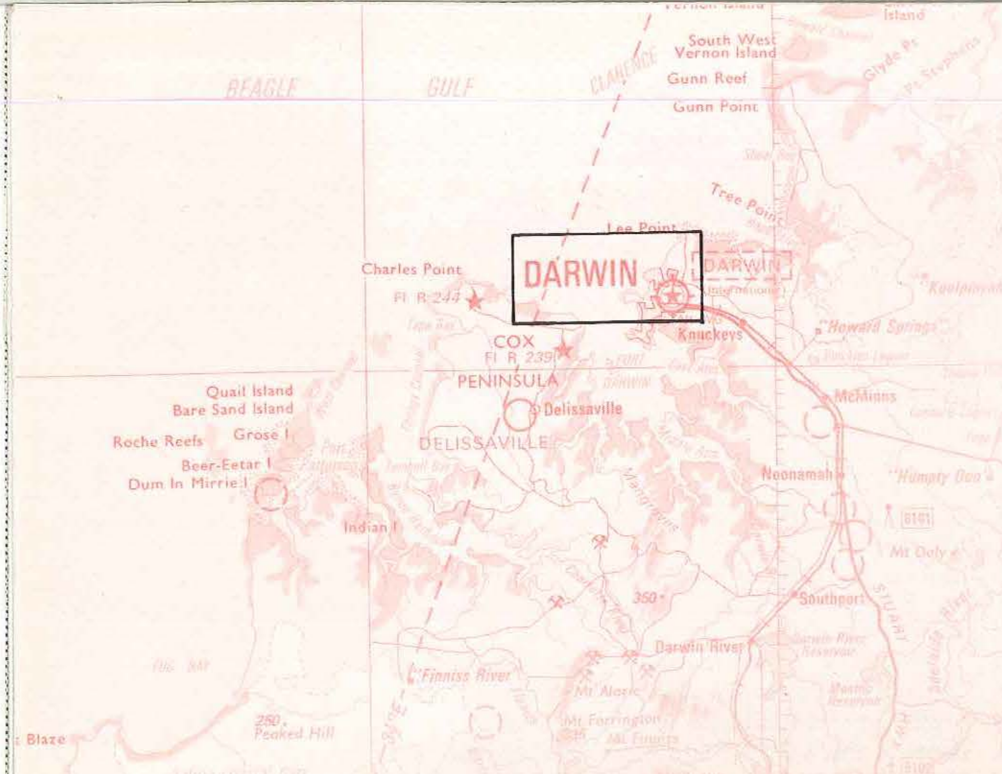
Since the wreckage of the aircraft was in an area difficult to reach, the airworthiness examination had to be completed on the spot. Although the engine was dislodged and the wing structure broken and torn, damage to the fuselage was much less severe. All four seats were still attached, and the restraint harnesses were intact.

The fact that the two children sitting behind their parents in the aircraft survived the accident without injury, together with the results of the post-mortem examination on the adults showed that this accident should have been survivable. It was found that the blows that killed the pilot instantly and fatally injured his wife were not caused by the impact of the crash. Rather they had been inflicted when the heavy drum scrubber wheel had burst from its restraint in the rear luggage compartment and had smashed its way around the front cockpit as the aircraft gyrated on impact with the ground. It was this wheel that had trapped the children's mother in the aircraft.

The pilot did not expect to have an accident, of course, and the drum scrubber wheel probably seemed to him to be sufficiently secured against the normal forces of take-off and landing. But the lesson here is obvious: **it was not secure enough.**

This was a particularly tragic accident which killed a young man and his wife and orphaned their children. Like most other accidents of this sort it could have been avoided. Yet, considering the circumstances, it is even more saddening to realise that even though the accident itself occurred, the pilot and his wife need not have died as a result.

The wrecked aircraft lying on the hillside in dense undergrowth. Impact damage to the cabin area was less severe than the picture indicates as it was necessary to cut into the wreckage to extricate the occupants.



There's many a Slip...

After an early morning departure from Weipa, Queensland, a twin-engine business aircraft flew to Groote Eylandt, Northern Territory, where it landed just after 0900 hours.

The aircraft, engaged on an extended round-Australia flight, had left Melbourne three days earlier, flying in stages to Weipa via Canberra, Mackay and Moranbah. The purpose of the flight was to enable the aircraft's passengers to visit several large mining centres in the far north.

At Groote Eylandt, the crew rested while the passengers went about their business. The captain then had the aircraft refuelled and later telephoned Gove Flight Service Unit to submit details of an IFR flight that afternoon to Jabiru, 116 nautical miles east of Darwin, thence to Darwin itself. The passengers were to leave the aircraft at Jabiru while the crew took it on to Darwin. The aircraft was to return to pick them up in two days' time. The planned time interval from Groote Eylandt to Jabiru was 60 minutes, cruising at flight level 185, with a further 29 minutes to Darwin at 10 000 feet.

Taking off from Groote Eylandt at 1652 hours, the aircraft completed the first leg of the flight without incident and landed at Jabiru at 1747 hours. The passengers were met and were driven away from the airstrip in cars which had been awaiting their arrival.

At 1817 hours, some 27 minutes before last light, the aircraft called Mt. Isa Flight Service on HF to advise it was taxi-ing at Jabiru for a departure on the 09 strip. The information was passed to Katherine, in whose area the aircraft was operating and it was instructed to call Katherine on departure. Four minutes later at 1821 hours, having been unable to obtain a reply from Katherine, the aircraft again called Mount Isa, advising it had departed Jabiru for Darwin with an ETA of 1850 and requesting an airways clearance. The departure report did not include advice of the aircraft's outbound track which should have been given on this occasion in accordance with the AIP.

While climbing, the aircraft called Katherine on HF and, at 1828 hours, a clearance to 'enter control area, track Jabiru direct to Darwin at one zero thousand' was passed to the aircraft with an instruction to call Darwin Control on the appropriate VHF frequency. But three minutes later, the pilot again called Katherine to report he had been unable to contact Darwin. Once more the aircraft's transmission was not received by Katherine but Tennant Creek responded, requesting that the pilot try Darwin Control again. Shortly afterwards, Katherine was successful in contacting the aircraft, and suggested that a call be made on the Darwin Approach frequency as well.

Nothing was heard from the aircraft in Darwin on either VHF frequency and calls to it from Darwin also produced no response. At 1836 hours, the pilot advised Tennant Creek he was still unable to contact Darwin and confirmed his original ETA of 1850. Yet another Darwin VHF frequency was suggested but without success. Two minutes later at 1838 hours, the pilot advised Katherine he was 40 miles from Darwin by dead reckoning and that the aircraft's DME was inoperative.

All appropriate VHF frequencies, including Darwin Tower and even Surface Movement Control were again tried and, at 1841, only nine minutes before ETA, the captain reported he had been 'unable to make contact on any of those frequencies'. He then gave the aircraft's position as 20 miles from Darwin by dead reckoning.

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Meanwhile, it had been arranged between the various airways operations units for the aircraft to commence an approach into Darwin with an initial descent to 2500 feet, with communications being relayed through Katherine. But at 1844 hours, just as a clearance to descend was about to be passed to the aircraft, the pilot called Katherine, still on HF, and advised: 'Disregard previous D/R position, we are approximately 170 miles east of Darwin and we have a new estimate coming up. We would like to climb to flight level 160 and request a new clearance'. In response to a query from Katherine, the pilot confirmed the distance he had given was correct and that the aircraft was in fact further away from Darwin than the point from which it had taken off.

It was now obvious to all that the aircraft had flown the wrong way after taking off from Jabiru and, a short time later, it was given a new clearance to track direct to Darwin at flight level 160. At the pilot's request, this was subsequently amended to flight level 180 and the aircraft at last was able to establish contact with Darwin on VHF. The remainder of the flight was uneventful and the aircraft eventually landed at Darwin, 77 minutes after leaving Jabiru.

* * * * *

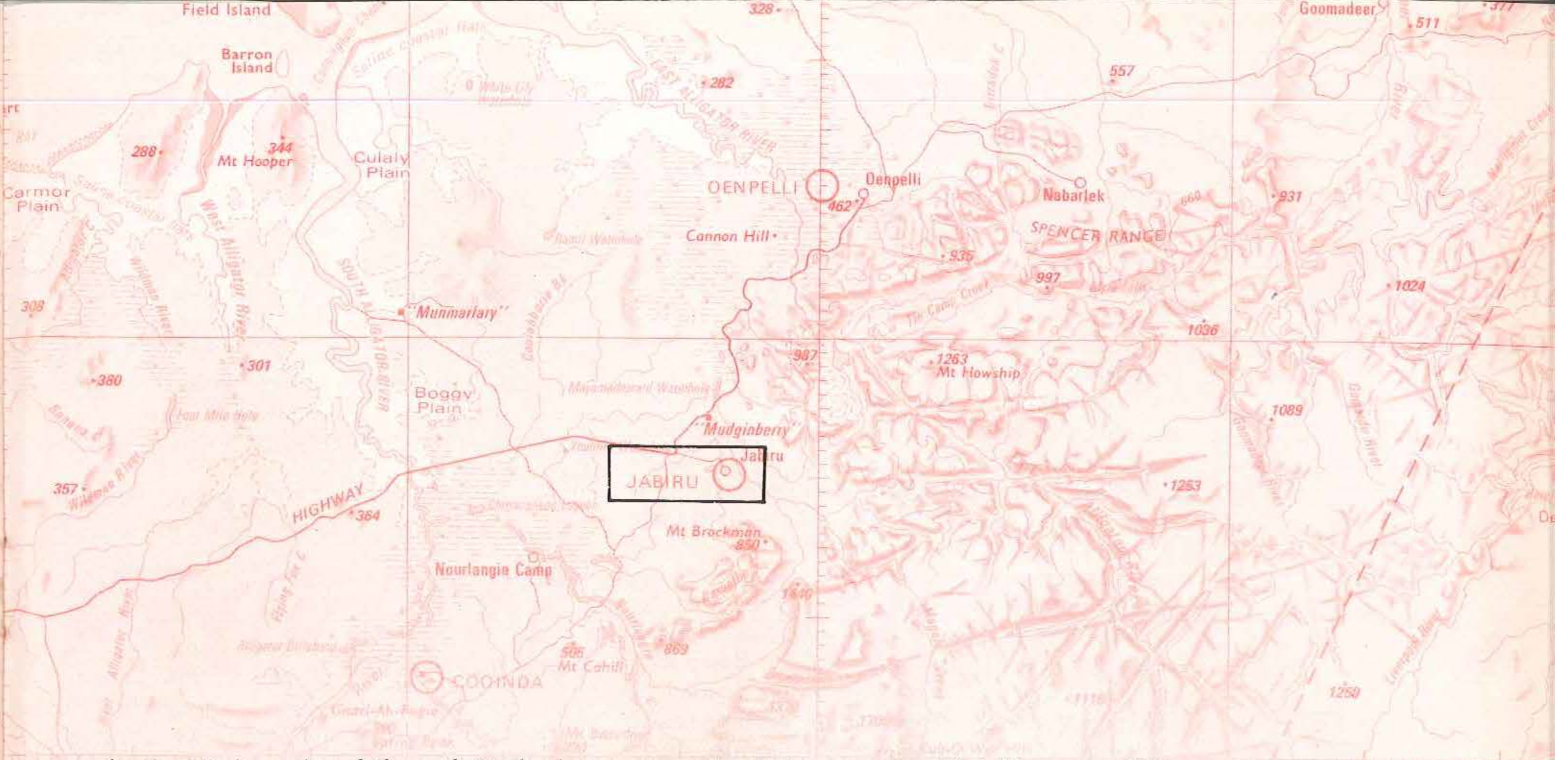
Before taking off for Darwin, the captain had briefed the first officer to fly the leg as first pilot from the right hand seat. As the nose wheel is steerable only from the left hand seat, the normal take-off procedure used by the operator when the aircraft is being flown by the first officer, is for the captain to taxi the aircraft and carry out the first part of the take-off until V_1 is reached. At V_1, the captain hands over control to the first officer, who then acts as first pilot from the right hand seat while the captain operates the radio and attends to other cockpit duties.

The strip surface and aircraft parking area at Jabiru are rough and stony and the captain, concerned about stone damage to the propellers, instructed the first officer that they would complete the necessary radio calls and as much of the pre-take-off drills as possible before starting the engines. In this way, once the engines were running, the aircraft could be kept rolling to avoid stones being drawn into the propellers. The cockpit checks and start-up were conducted as planned, and as there are no radio-navigation aids at Jabiru, the receivers were selected to the Darwin frequencies, though it was not possible to tune the aids on the ground.

In addition to the standard flight plan form, it is the operator's practice to use a Flight Deck Log. This form contains details such as planned flight levels, radio frequencies, tracks and time intervals transcribed from the flight plan, together with other information likely to be referred to on a routine flight. On this occasion, the flight deck log had been prepared by the first officer before departure. The first entry contained all relevant details for the flight from Jabiru to Darwin, including the track of 273 degrees magnetic, the planned altitude of 10 000 feet and the estimated time interval of 29 minutes. But a few lines below this entry, the first officer had also inserted the track of 093 degrees magnetic, the distance and the estimated time interval for the return flight from Darwin to Jabiru, even though this was not due to take place for another two days.

The aircraft concerned is equipped with two separate flight director systems, one for the captain and one for the first officer. These particular flight directors incorporate two basic instruments — a flight director indicator, displaying aircraft attitude, and a course deviation indicator (CDI). The CDI in each system is fitted with an adjustable heading marker or 'bug' and a course deviation bar, both of which are set by reference to the rotatable azimuth card. But in this aircraft, there is no corresponding digital readout of the headings selected.

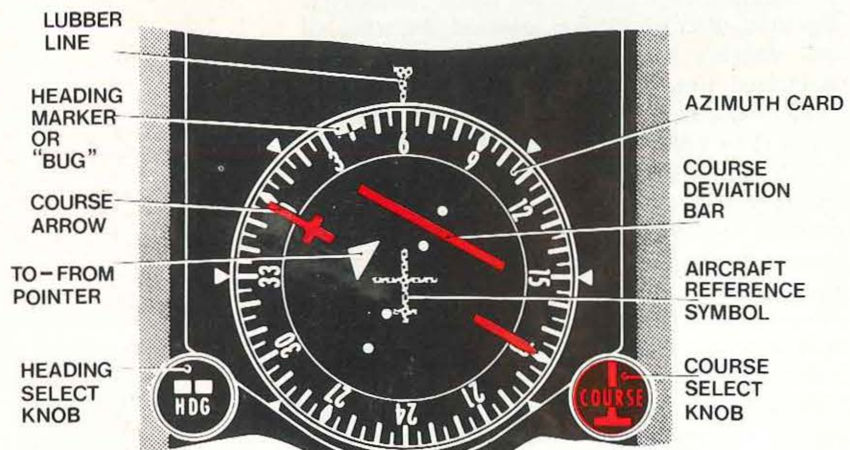
It is the operator's normal procedure for



each pilot to set runway heading on the heading bug and initial track on the course bar before take-off. The direction of the strip being used at Jabiru was 090 degrees and, during the pre-take-off cockpit checks, the heading bugs were duly set to 090. As well, tracks were set on the course bars but, following the crew's quick reference to the last line of the flight deck log, 093 was set instead of the correct Jabiru - Darwin track of 273 degrees. In this way, the reciprocal of the required track was set up on both CDI's. After take-off, the first officer, flying the aircraft from the right hand side, simply took up the selected track of 093 degrees. Later, he remembered thinking at the time 'how convenient it was to be able to take-off and continue straight ahead'.

During starting and taxi-ing, the crew were preoccupied with the condition of the strip and in adopting the correct technique to avoid propeller damage on the stony surface. They were also engaged in establishing radio contact on HF and making their initial taxi-ing calls. After handing over control of the aircraft to the first officer during the take-off, the captain, anxious to obtain an airways clearance as quickly as possible, devoted virtually his whole attention to handling the radio communications. Operation of the HF radio was complicated by poor propagation conditions at that time of the day, as well as by the fact that though the captain was able to transmit from his position, the HF frequency selector was situated on the right hand side of the cockpit and was out of his reach. Thus, all HF frequency changes, and there were several, had to be made by the first officer who was also hand-flying the aircraft. Throughout the climb and early part of the cruise, the captain also made numerous calls on the appropriate VHF frequencies in an attempt to establish communication with Darwin.

Because they were unable to contact Darwin on any VHF frequency, or receive usable signals from any of the VHF navigation aids, the crew assumed the aircraft had suffered complete failure of all VHF equipment, though the cause was not obvious to them. In actual fact of course, the aircraft was out of range of the aids, and heading even further away from them.



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In retrospect, several factors stand out clearly as having set the stage for this very serious incident. First among these was the final entry on the flight deck log, which set out full details of the return flight from Darwin to Jabiru, including a time interval, even though this was not due to take place for another two days.

Secondly there was the distraction resulting from the crew's preoccupation with the surface of the strip and the captain's concern to demonstrate to the first officer, who was unfamiliar with this type of operation, the techniques necessary to avoid stone damage to the propellers. Thirdly, once the aircraft was airborne, the captain immediately applied himself to the radio communications. As a result, neither he nor the first officer checked that the aircraft had taken up the correct departure heading. Operating the radio was to occupy even more of the captain's time and attention as the aircraft headed further away from Darwin.

With no radio-navigation aids at Jabiru from which the aircraft could back-track, it was important for the crew to verify as soon as possible after take-off that the aircraft had taken up the correct heading for Darwin. The aircraft took-off from Jabiru some 25 minutes before last light, the weather was fine and, though visibility was reduced because of haze, it should have been possible to obtain some visual fix. Perhaps, more significantly, Darwin and the required track were to the west towards the setting sun, but this cue remained unnoticed. Possibly the crew were tired after a long day; possibly they tended to relax after the passengers had disembarked.

Yet another link in the chain of events leading up to this incident was the omission of the captain to advise the aircraft's outbound track in his Jabiru departure report. The absence of this information was not pursued by the Departmental organisation. If it had been, it is possible that the error made by the crew would have been detected.

Certainly, some 20 minutes after take-off, when the aircraft should have been only nine minutes from Darwin, the captain became concerned that he was still unable to receive any usable navigation aid signals. It was only at this stage that he applied himself to a detailed cockpit check and discovered the error in heading. The aircraft was then turned around and climbed to flight level 180 to come within VHF coverage.

Altogether, the aircraft had flown for 23 minutes on the reciprocal of the intended track before the error was finally discovered.

While making a local flight in his aircraft, the pilot of a PA28-180 decided to return to the aerodrome. Increasing power, he rolled the Cherokee into a steep turn, but almost immediately the whole aircraft began vibrating severely. With no option but to close the throttle, the pilot made a forced landing in a nearby paddock. He then discovered that about 17 centimetres of one blade was missing from the propeller.

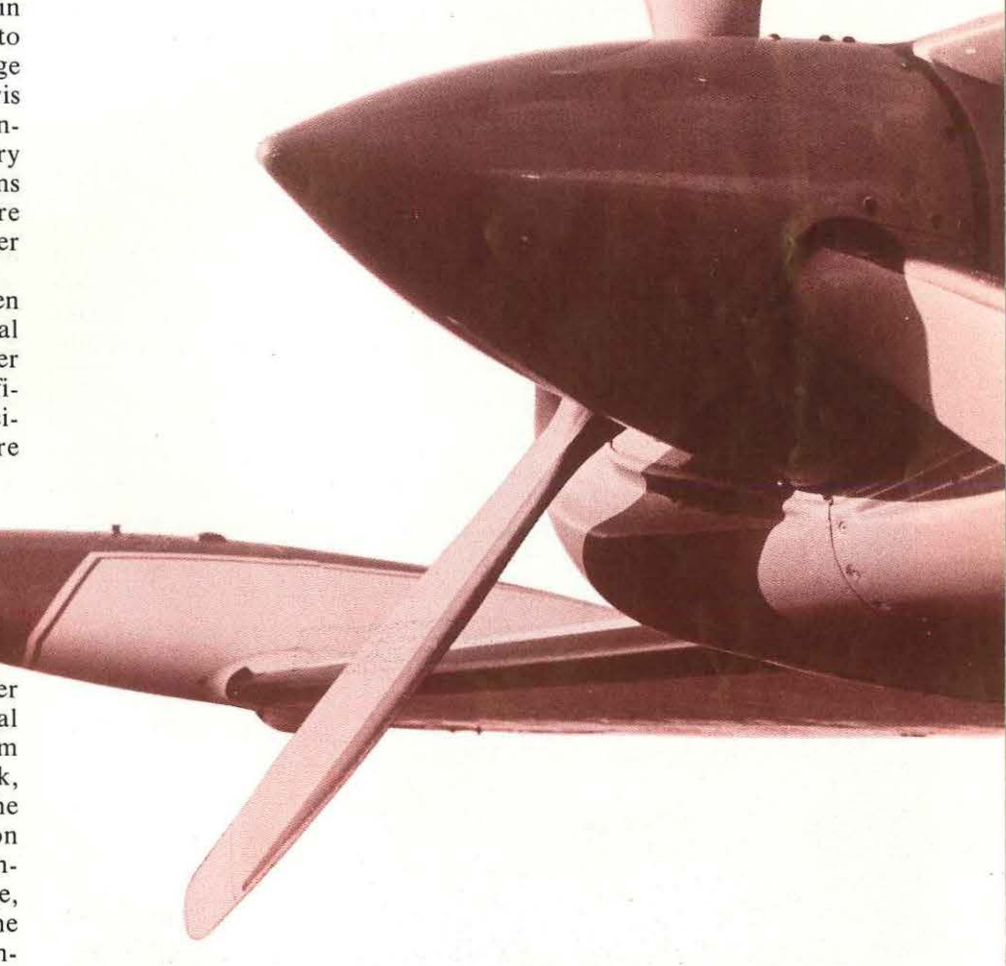
Unfortunately, the outcome of a propeller blade failure in flight is not always as uneventful. Indeed, only a month before this occurrence, a Musketeer lost half a propeller blade while flying IFR in cloud over mountainous terrain in New South Wales. The out-of-balance condition dislodged the engine from its mountings and the pilot was forced to descend. The base of the cloud lay close to the mountaintops and the aircraft finally crashed into the steeply sloping side of a ridge, killing the pilot, the only occupant.

PROPELLER FAILURE!

For reasons such as these, propeller blade separation in flight and the factors that can cause it are well worth serious study.

Of 280 general aviation incidents and accidents between the beginning of 1970 and the last quarter of 1976 in which propellers were damaged or became inoperative for various reasons, there were 19 occasions on which blades separated. Two of these occurred during take-off and the remainder in flight. The great majority involved fatigue failures in metal propellers. Fourteen cases were found to have been initiated by previous blade damage such as that inflicted by stones and debris picked up by the propeller. As well as these instances, propeller hubs or their ancillary equipment separated in flight on five occasions and twice during take-off. Fatigue cracks were found during the investigation of three other incidents.

When considered in relation to the seven million hours flown by Australian general aviation aircraft during the period under review, these figures may seem of small significance. Yet as we have seen from the fatal accident already mentioned, each and every failure has the potential for catastrophe.



In the case of the Cherokee 180's propeller blade failure, which is typical, metallurgical examination showed that it had resulted from the initiation and growth of a fatigue crack, finally leading to an overload failure. The fatigue crack had begun at a severe indentation in the rear face of the propeller blade. The indentation was in the form of a sharp gouge, typical of that caused by a stone impact. The absence of any peripheral lip around the indentation indicated that it had been partly dressed out subsequent to the damage. As well, black paint in the indentation showed that the rear face of the blade had been painted since the damage had been sustained.

The fracture surfaces of the separated blade exhibited two distinctly different zones, as shown in Fig. 1. One zone had a bright, faceted appearance with progression type markings — features typical of fatigue crack propagation. Portions of the fatigue zone on the mating fracture surfaces were stained a slightly darker colour and extended from the origin of the crack to a boundary line which followed the progression markings as indicated in Fig. 1. The other zone, of a dull, fine-grained appearance, was at a steep angle to the rear of the blade and was typical of an overload shear-lip. The fatigue progression markings all radiated from the sharp indentation, which can be seen in Fig. 2 at approximately the mid-chord of the rear face of the blade.

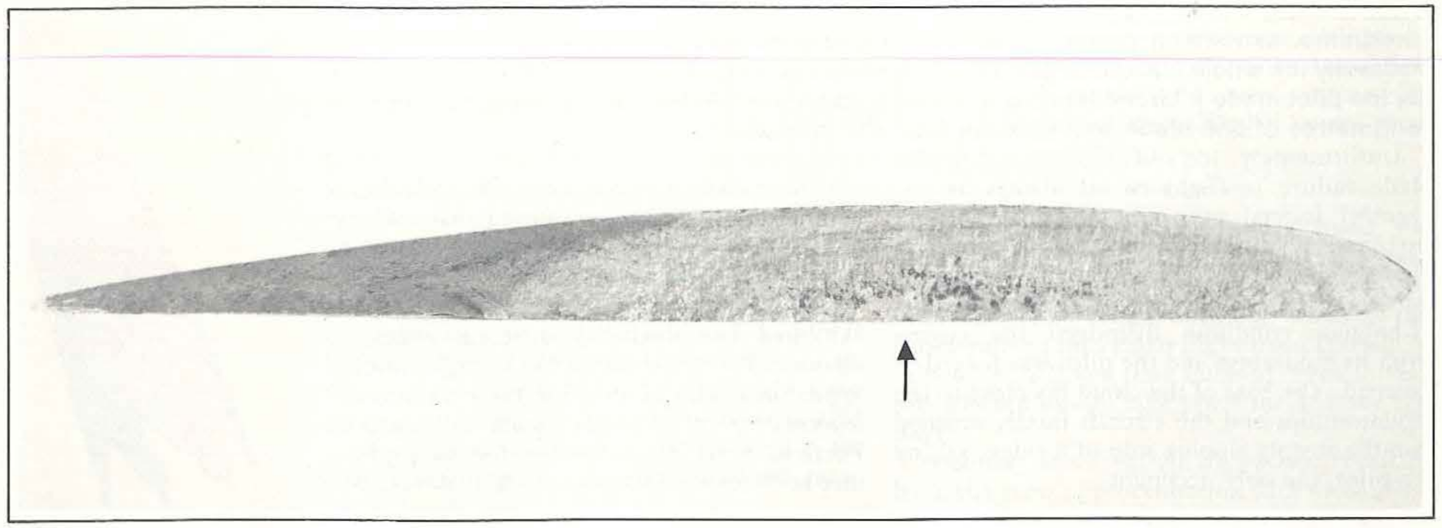
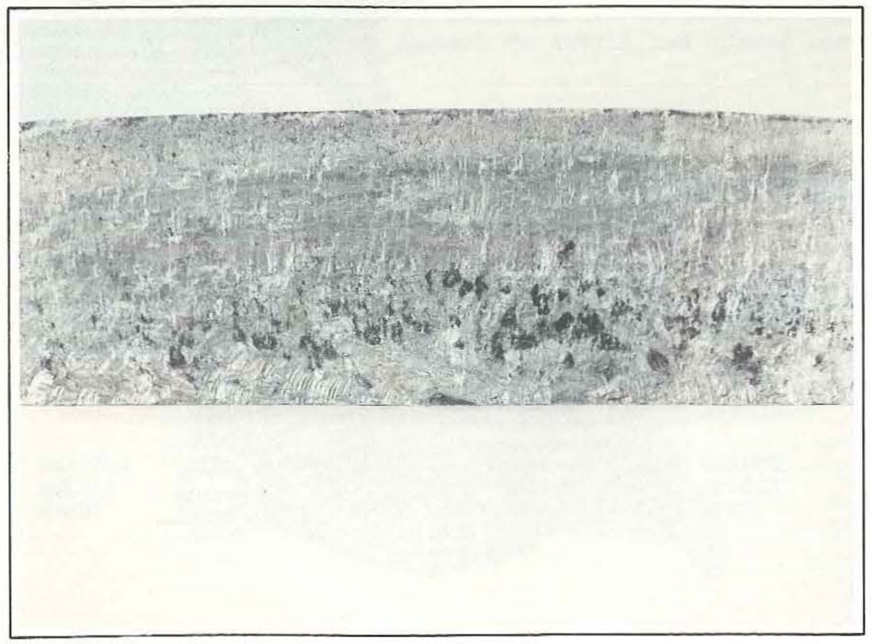


Fig.1 — Fracture face of propeller blade showing fatigue and overload zones. The indentation from which the fatigue crack started is indicated.

Fig.2 — Fatigue progression markings radiating from the indentation at which the fatigue began.



Fractographic examination, using a scanning electron microscope, revealed that the early stages of propagation consisted of a series of 'stepped' crack fronts (Fig. 3), with fine striations between them. The crack front propagated at approximately 45 degrees to the blade rear surface, with a change in the direction of propagation of approximately 90 degrees forming the 'stepped' growth pattern observed. The 'stepped' growth indicates that a significant change in the stress mode occurred periodically.

As a simplified analogy, the stresses that normally occur in a propeller blade may be considered as being produced by lines of force that run within the blade approximately parallel to the surface. But when a nick or a dent is made in a propeller blade it tends to disrupt the lines of force in the defect area, thereby increasing the stress. (Fig. 4). This increase in stress may be sufficient to cause a crack to start. In aluminium alloys, even a small defect such as a nick, a dent or even a spot of corrosion will develop into a crack if enough cycles of high alternating stresses are applied. The crack, in turn, results in a greater stress concentration than before and the resulting crack growth will almost inevitably result in blade failure.

For these reasons, inspecting the propeller is an important element in daily and pre-flight inspections. But what should the pilot be looking for as far as propeller damage is concerned and how can he assess its true significance? Can he detect that fatigue is present? How should he handle a dangerous looking indentation in the blade surface? Well, the pilot is now in engineering territory and it is to engineers he must be prepared to turn for advice if he has any doubt.

First, the pilot should be on the alert for anything unusual. In particular, stone damage and impact marks on the blades, abrasions, signs of bending — even a change of 'feel' of the blade in the hub. When inspecting a constant speed propeller, any unusual grease or oil leak warrants further examination. It may not be just a failed seal — the leak may be due to cracking of the hub or the blade inside the hub.

Deep nicks with sharp edges are potentially more damaging than shallow ones, but it is impossible by general inspection to assess the damaging effect of a particular indentation. Rather, all such damage should be regarded as a latent source of danger. This applies not only to leading edge nicks but to damage occurring on the rear face of the blade, back from the leading edge. Although blade tip failures predominate, special attention should be given to any damage, such as nicks and cuts, further up the blade. The resulting drastic imbalance from a propeller blade failure in this area could result in the engine being flung from its mountings.

A grey 'spotting' on an anodised blade surface may indicate surface corrosion. Corrosion can extend quite deeply into the blade and has a similar effect to severe stone damage, with cracks forming from the base of the corrosion pits.

Once a crack has started, its propagation rate may be rapid. It may extend to the stage of blade failure during a period of the order of tens of flights — not hundreds. Changes in power or propeller revolutions are fatigue-inducing factors, and the crack propagation rate is affected by both the number of flights and the hours flown. A crack cannot usually be detected during the preflight inspection until it has reached a very advanced stage and the blade is well on the way to final failure.

When damage in the form of a nick is found it should be removed as soon as possible. For once a crack has started, the only way to stop it is to remove the metal to the end of the crack and beyond it. This is a task for the Licensed Aircraft Maintenance Engineer, who knows how to work within the propeller manufacturer's tolerance limits as to the amount of metal that may be removed in carrying out the repair. The maintenance engineer dresses the damaged surface, working longitudinally along the blade and not across it, to ensure that the damage is totally removed. He blends out the surrounding metal and completes the repair by polishing the affected area finely with an emery cloth.

It needs to be said however, that fatigue failure can still occur in a propeller, even where treatment for blade damage has been carried out previously. This can result from a fatigue crack actually having started before the repair work was undertaken, and subsequently remaining undetected. It can also occur of course if the earlier repair was not properly performed.

Propeller manufacturers' maintenance instructions contain information concerning the limitations for the straightening of deformed blades. Exceeding these limitations may also result in blade failure during operation. Blade straightening or repitching should always be followed by correct anti-corrosion treatment, as blade failure can start in corrosion pits forming in cracks in the anodising. Corrosion pits may also form in areas where stone damage has abraded the anodised layer.

As well as looking for any unusual 'danger signs' in propellers, during daily and preflight inspections, pilots would be wise to spend a little extra time occasionally to check the tracking of the blades. This can be done quite simply with any suitable blunt-ended pointer — such as a broom handle. The pointer is first firmly attached to the aircraft structure and adjusted so that it abuts the rear face of the propeller and just contacts the trailing edge of one blade close to the tip. Next, the propeller is rotated backwards slowly until the next blade is adjacent to the pointer. If the blades are tracking perfectly, the trailing edge of this blade should again just contact the pointer. If there is a difference in the pointer-blade relationship, the blades are out of track. A difference of up to 2.5 mm is acceptable for a metal propeller, while up to 3 mm is satisfactory for wooden propellers. Any greater difference in blade tracking can indicate a bent propeller blade, or in the case of a constant speed propeller, could mean that a serious crack has developed in the blade butt or hub.

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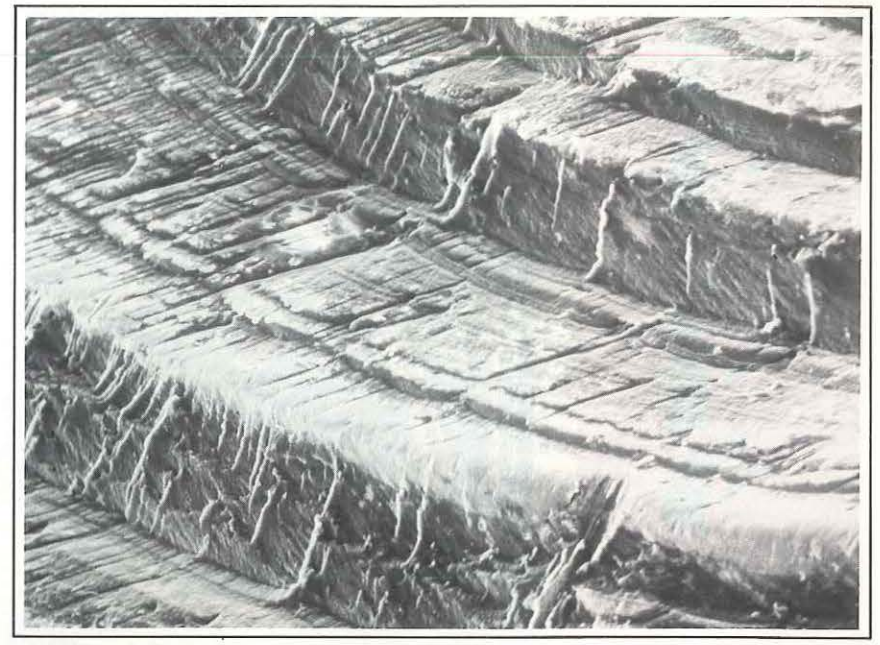


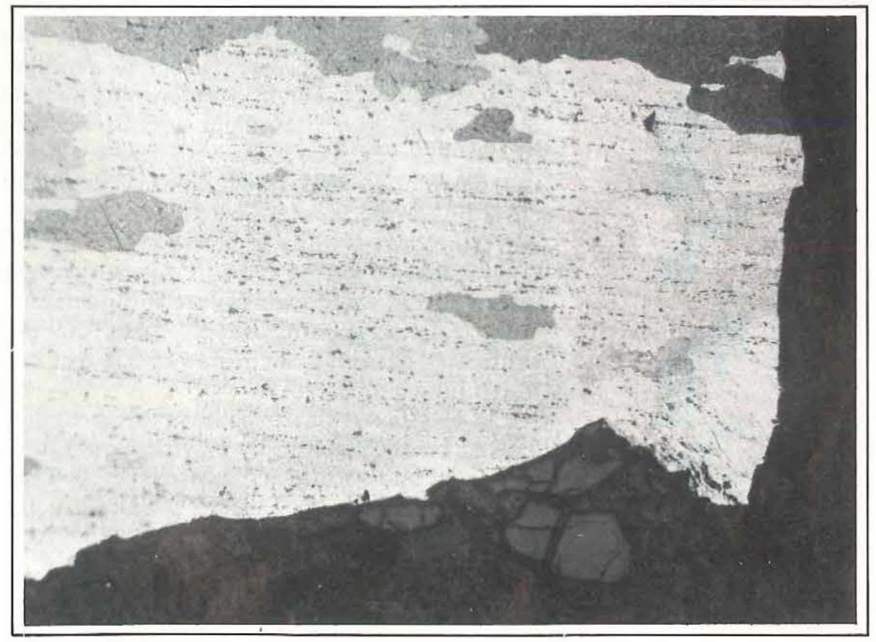
Fig.3 — Electron microscope photograph, using a magnification of 525 times, showing the stepped fatigue crack growth.

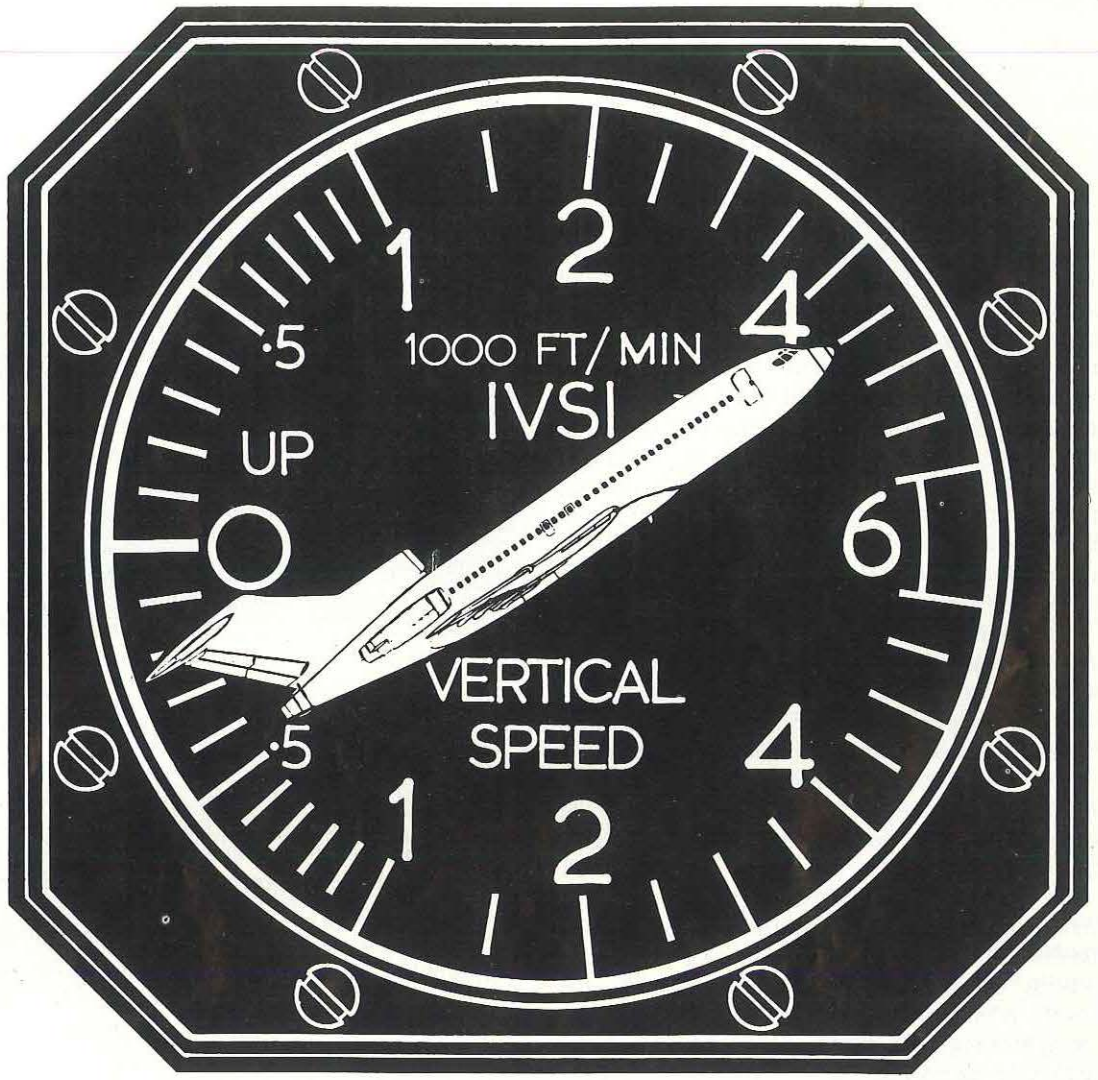
It is a truism, but it works — look after your propeller and it will look after you! Most blade failures occur as a result of fatigue cracks which start at mechanically formed dents or corrosion pits. Failures which develop from surface discontinuities existing in the metal before the blades were placed in service are relatively rare.

So exercise care with your propeller by selecting taxi paths and run-up areas which are free of stones and debris. And be equally discriminating in your choice of runway path, especially the area where you will apply power.

Blade and socket failures can usually be detected by changes in the level of engine vibration. Train yourself to be aware of the general level of vibration in your aircraft in the air and have any significant change in this level investigated. Your propeller could be trying to tell you it has a problem!

Fig.4 — Sharp indentation close to fatigue origin, magnified 150 times.





Reprinted with acknowledgment to FAA 'General Aviation News'

On the night of December 1, 1974, an aircraft climbing through cloud stalled and crashed into the side of Bear Mountain in New York State, USA, killing all three persons on board.

Fatal stalls in cloud are, unfortunately, not an uncommon experience in civil aviation. What made this accident different was the fact that it occurred not to a light aircraft, but to a Boeing 727-251, equipped with the very finest instrumentation and flown by a professional crew all properly certificated and qualified. Nevertheless a condition developed which was not recognised by the crew in time to prevent the stall, and the crew's failure to understand what was happening resulted in an uncontrolled descent from nearly 25 000 feet into the ground.

On this particular flight the three-engined jet had been chartered by a professional football team and was on its way from New York Kennedy Airport to Buffalo to pick up the players. There were no passengers on board at the time.

The aircraft departed at 1914 hours during a period when moderate to heavy snow and rainshowers had been forecast, with 'frequent moderate icing' in cloud. The crew consisted of the captain, and the first and second officers, all of whom were properly certificated and qualified for the flight in accordance with FAA and airline regulations. The aircraft was determined to be fully airworthy and loaded correctly as to weight and balance. It was equipped with both a cockpit voice recorder, which retains the last 30 minutes of cockpit noises and conversation, and a flight data recorder which stores such information as heading, airspeed, altitude, and vertical acceleration.

The Boeing 727 has three independent pitot systems and three independent static systems. In addition to providing sensory information to airspeed and other instruments for the pilots and the flight data recorder, two of the systems are designed to activate warning horns whenever the aircraft approaches maximum operating speed, which is approximately Mach 0.9.

The cockpit voice recording of the 727 began shortly before take-off with the pre-flight checklist being read by the second officer. The first officer responded, apparently under the supervision of the captain. One segment of the printed checklist reads as follows:

Second Officer	**First Officer**
Flaps	15, 15 (25, 25)
Marked Bug (*Marker showing rotation speed set on airspeed indicator*)	Numbers set
Ice protection (*engine nacelle heat*)	OFF(ON)
Pitot Heat	ON

A transcript of the actual readout and response shows that after the first officer responded to the flap-setting query, and the second officer called for the 'bug' setting, there was no immediate response — and that consequently the engine anti-ice query was skipped:

First Officer: *(responding to 'Flaps?')* 'Zero, zero and thirty-one, fifteen, fifteen . . .'
Second Officer: 'Bug? . . .'
Second Officer: 'Pitot heat?'
First Officer: 'Off and on.' *(He was apparently responding to the missed query on engine anti-ice, and to the pitot heat item.)*
Captain: 'One forty-two is the bug.'
First Officer: 'Er . . . do you want the engine heat on?'
First Officer: 'Huh? *(Perhaps responding to a hand signal.)* Sound of five clicks.

Because the sequence of items in the checklist was interrupted, it seems likely that a mistake occurred at this point, and that the five clicks heard on the tape were the movement of the pitot heater switches to the 'OFF' position, together with the movement of the engine anti-ice switches to the 'ON' position — a reversal of their normal positions on take-off. The investigators found this assumption supported by the position of these switches in the wreckage, by the condition of the engine anti-ice lights, and by the lack of any reference during the flight to the need for engine anti-ice.

According to the voice recorder, apart from the irregularity in this checklist, all other preparations for the departure proceeded in a standard manner, and at 1914 hours the three-engine jet left Kennedy Airport on a standard instrument departure. The aircraft was first cleared to 14 000 feet by Departure Control and then to 31 000 feet by the New York Centre. As the aircraft climbed through 13 000 feet, a climb rate of 2500 feet per minute was established with the airspeed at 305 knots. So far, everything was normal.

But as the aircraft climbed through 16 000 feet, the indicated airspeed began to increase (with no change in power setting). Oddly enough, the rate of climb indicator also began to show a marked increase. The first officer commented: 'Do you realise we're going 340 knots and I'm climbing 5000 feet a minute?'

Implications of the high airspeed and the high rate of climb (which are beyond the performance capability of the B727-251) were then discussed by the crew and the second officer concluded: 'That's because we're light'.

Nowhere in the recorded conversation was there speculation that the instrument readings could be wrong or that ice could have sealed off the pitot tube heads, rendering the airspeed indication totally false. (In certain circumstances, when the pitot tube system is sealed off by ice or other blockage, the instrument's indication is no longer related to airspeed at all, but acts something like an altimeter, showing an increased reading as the aircraft climbs and a decrease as it descends, regardless of actual airspeed).

The first officer, who was handling the flight controls, continued to exert back pressure in an effort to prevent the airspeed from becoming excessive. But as the aircraft passed through 23 000 feet the recorded rate of climb was more than 6500 feet per minute, the indicated airspeed was 405 knots and the overspeed warning horn, which is linked to the airspeed indicator, sounded. At this point the following conversation was recorded:

Captain: 'Would you believe that —?'
First Officer: 'I believe it. I just can't do anything about it.'
Captain: 'Pull her back and let her climb.'

The overspeed warning horn was heard again, followed ten seconds later by the sound of the stall warning stick-shaker, which is independent of the airspeed measuring systems. The flight data recording showed that within another five seconds the vertical acceleration had reduced to 0.8g and at 24 800 feet, the aircraft stopped climbing. Airspeed indication was 420 knots. The aircraft was now on the verge of a stall, and the stall warning device activated again.

First Officer: 'There's that Mach buffet, I guess we'll have to pull it up.'
Captain: 'Pull it up.'

Mach buffet is a vibration that takes place when an aircraft exceeds its critical Mach number, which is the ratio of the aircraft's speed to the speed of sound at a given altitude. The buffet is caused by the formation of a shock wave on the aerofoil surfaces and a separation of airflow aft of the shock wave. The change from a laminar flow of air to turbulent flow causes a high frequency vibration in the control surfaces, which is described as a 'buffet', or 'buzz'. Apparently the first officer and the captain — believing the airspeed to be 420 knots — mistook the stick-shaker stall warning effect for the Mach buffet.

The landing gear warning horn then sounded, indicating that the throttles had been retarded with gear up.

Thirteen seconds after reaching 24 800 feet, the aircraft was falling at a rate of 15 000 feet per minute, turning rapidly to the right. The airspeed indication was decreasing at a rate of four knots per second.

'Mayday! Mayday!'

The New York Air Route Traffic Control Centre acknowledged the call immediately. 'Go ahead . . .'

'Roger, we're out of control . . . descending through 20 000 feet.'

The centre controller advised that altitudes below the jet were clear of traffic, and asked for details of the emergency.

'We're descending through 12 — we're in a stall!'

It was their last transmission. The recording tapes picked up a command from the captain — 'Flaps two!' — and a sound which might have been the movement of the flap handle. But there was no apparent reduction in the rate of descent, which was recording peaks of more than 3g. Airspeed indication went to zero, and the stall warning horn sounded intermittently. The last voice recording was at 1925 hours.

First Officer: 'Pull now! Pull — that's it!'

The flight data recorder showed that vertical acceleration then increased to 5g. Most of the left horizontal stabiliser separated at about 3500 feet, rendering the big jet uncontrollable and the aircraft crashed into frozen ground at the base of Bear Mountain at an elevation of 1900 feet, having fallen from 24 800 feet in 83 seconds. There was no fire, but the three-man flight crew — the only persons on board — were killed on impact.

The investigation of the accident, carried out under the supervision of the National Transportation Safety Board with the participation of the FAA and air carrier and manufacturer's representatives, found no evidence of system malfunction or failure, or any structural defect in the aircraft. Significant findings of the Board included:

- Weather conditions encountered during the flight were conducive to the formation of 'moderate' airframe ice. The flight crew had been adequately briefed on the weather.
- The pitot head heater switches had not been turned on (contrary to standard operating procedures).
- At an altitude of about 16 000 feet the inlet ports and drain ports of the pitot heads had become completely blocked by ice.
- The complete blockage of the pitot heads caused the airspeed indicators to read erroneously high as the aircraft climbed above 16 000 feet and the static pressure decreased.

* * * * *

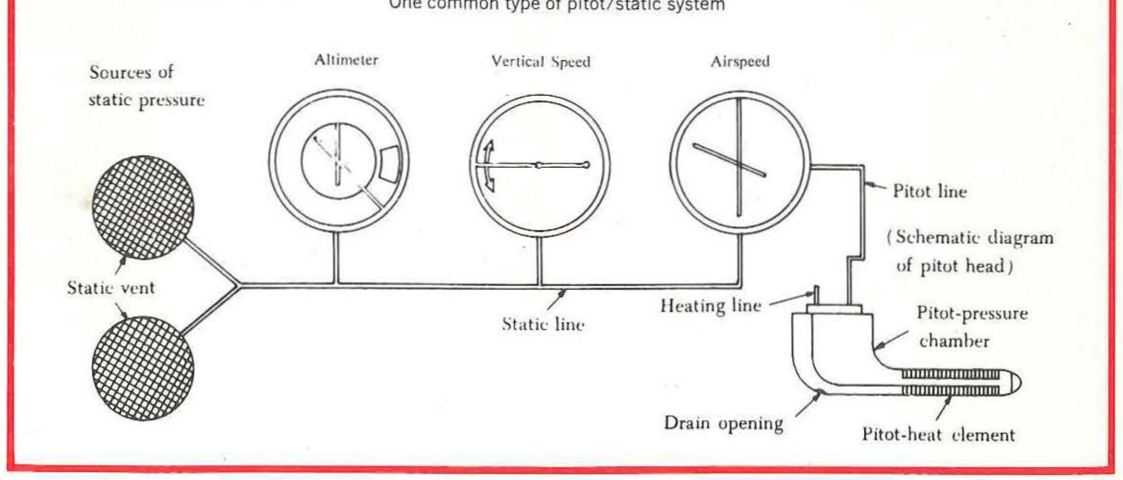
To understand this latter statement, it is necessary to have some idea of how an aircraft's airspeed measuring system works. The standard pitot system is based on the fact that when an aircraft moves through the air, pressure is created ahead of the aircraft. This is known as **dynamic** pressure, as distinguished from **static** pressure, which is the atmospheric pressure of the air at any given altitude. When a symmetrically shaped object, such as a pitot head, is placed in the airstream, the flow of air will separate around the nose of the object so that the local velocity at the nose is zero. At this zero velocity point, the total pressure can be measured; it is the sum of the dynamic pressure, or ram air, added to the ambient static pressure.

The total pressure measured by the pitot head is transmitted through the pitot system plumbing to one side of a differential pressure measuring instrument. The ambient static pressure, which is measured at static ports located in areas not significantly influenced by the airstream, is transmitted to the opposite side of the instrument. The instrument, in effect, subtracts the ambient static pressure from the total pressure and displays the difference as increments of airspeed.

It may help to visualise the airspeed indicator instrument as a kind of closed cylinder with a diaphragm in the centre, separating the total pressure side from the static pressure side. It is apparent that such an instrument's readout would not be affected by changes in altitude, under normal circumstances, because of the presence of static air on both sides of the diaphragm. However, if the air in one side — say the total pressure side, which is linked to the pitot tube head, were to become sealed off by icing over the inlet ports, the instrument would function like an altimeter. As the altitude increased, the pressure on the static side would lessen, transmitting an apparent increase in dynamic pressure in terms of airspeed. This explains why the pitot-iced 727, on the verge of a stall at 24 800 feet, was still indicating over 400 knots of airspeed.

It also explains the confusion of the flight crew at that point, given their failure to consider the possibility of an error in the airspeed readout, and their fatal delay in recovering control of the aircraft. Actually, the loss of control came as a climax to a series of misjudgements arising from a very elementary mistake — the sequential interruption of the pre-take-off checklist reading, when the engine anti-ice item was skipped over. This disruption apparently led to taking off without the pitot heat being turned on, which in turn led to pitot icing, to airspeed errors, to excessive pitch, to mistaking stick-shaker vibration for Mach buffet, and so on.

One common type of pitot/static system

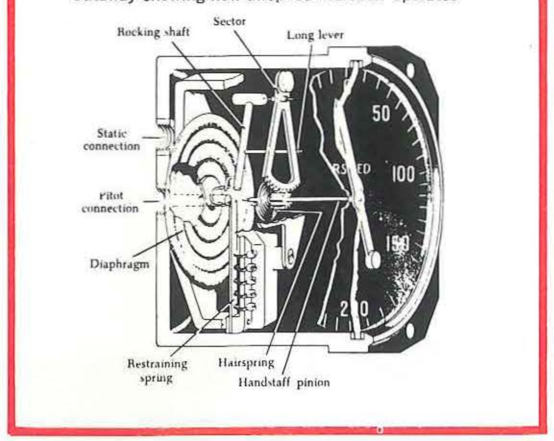


Interruption of checklist duties is a notorious cause of aircraft accidents. The only safe procedure, when this occurs, **is to go over the list again from the beginning, item by item.**

A second mistake on the part of the flight crew was the decision to accept as factual a condition of flight which, according to the book, was impossible to achieve in terms of airspeed and rate of climb. The only safe procedure under these circumstances would have been to stabilise the aircraft, in level flight with the co-operation of Air Traffic Control, and to check out the panel until the mystery was cleared up.

A third major mistake contributing to the fatal crash was the failure of the flight crew to use the attitude information displayed. A glance at the artificial horizon, for example, should have indicated that the nose-up attitude was about 25 degrees higher than normal. And at the top of the ascent a nose-up attitude of nearly 30 degrees was achieved. As experienced pilots they should have realised that at such an angle, a continued increase in airspeed was out of the question, even if influenced by an extreme updraft.

Cutaway showing how airspeed indicator operates



Lack of awareness of this extreme attitude, the Safety Board concluded, contributed to the confusion of the pilots to the extent that, even after they had perceived that they were in a stall, they were fatally slow in executing proper stall recovery procedures.

The Improbable Can Happen!

The pilot of a Piper PA-28-180 en route to Moorabbin Airport, Victoria, from a country aerodrome, was diverting to an Authorised Landing Area some thirty kilometres from Moorabbin because of a faulty radio receiver.

Overflying the landing area at 2000 feet while he checked his VFG-AGA for information on the airfield, the pilot completed the downwind checks and positioned his aircraft for a left base to runway 35. As he turned on to base leg, he closed the throttle, selected carburettor heat to 'hot' and applied first and second stages of flap.

The pilot then reached across and took a clipboard and his VFG-AGA from the lap of the passenger in the front right-hand seat and put them on the back seat. After selecting full flap on final approach, the pilot advanced the throttle but the engine did not respond. Suspecting carburettor icing he checked the heat control, then pumped the throttle. The engine responded spasmodically for a moment but failed to regain normal power.

With the aircraft losing height rapidly there was insufficient time to perform a trouble check, and a forced landing short of the runway became inevitable. The pilot headed for a small area clear of trees to the left of the approach path but soon after touching down, the starboard wing hit a tree and the aircraft was spun through 180 degrees. No one was injured, but as the photograph shows, the aircraft was substantially damaged.

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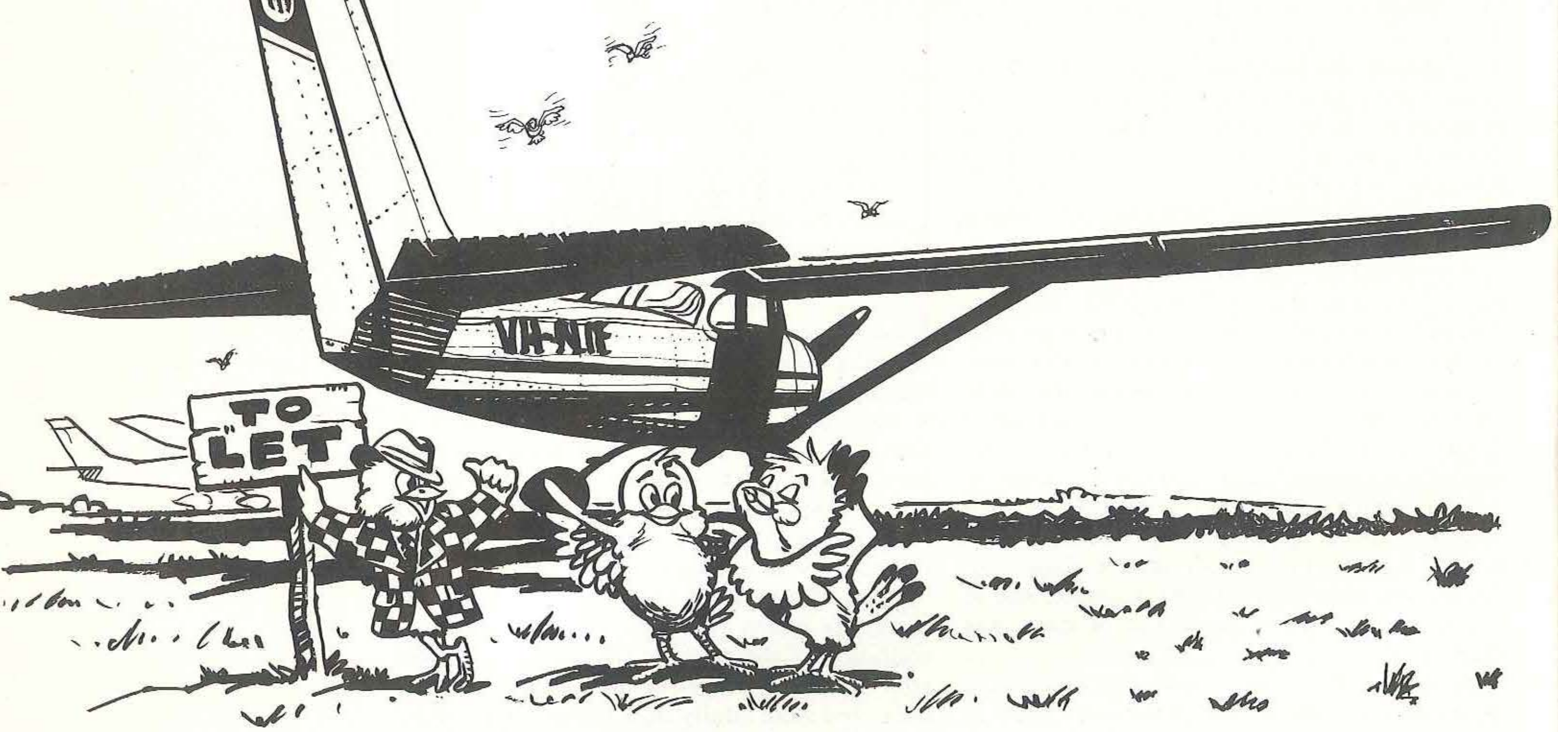
When the dust settled, it was found that the mixture control was in the idle cut-off position and there was a broken VFG-AGA binder ring on the cabin floor below the mixture control. The mixture control could be moved freely.

The circumstances strongly indicated that when the pilot took the clipboard and VFG-AGA from the lap of the passenger alongside him, one of the VFG-AGA binder rings caught on the mixture control knob, inadvertently pulling it into the idle cut-off position. No other causal factors could be found to explain the accident.

The message of this accident, though highly unusual, is nonetheless obvious — watch out for binder rings and similar 'traps' in the cockpit. There is at least one pilot who now knows what a hazard they can be!

ALL MOD CONS?



Man is attracted to aircraft because they enable him to rival the birds. Yet from time to time it seems that even the birds themselves are attracted to aircraft — but not because they want to rival us!

When springtime comes around, birds begin to build their nests. And an aircraft parked in the open can be a very attractive nesting site. The engine has many features which commend it to the enterprising bird in search of a good home: it is damp-proof, warm, well ventilated, and easily accessible when the propeller is left set up as a horizontal perch. Other areas in an aircraft can make even more exclusive residential areas, but they are sometimes hard to get to.

This, however, did not deter the sharp bird which had its eye on a Cessna 177 as a likely development site.

The aircraft, belonging to a local aero club, had been parked in the open at Camden, N.S.W. for some time. One morning during the preflight inspection, bird droppings were noticed on the empennage of the aircraft and a wisp of straw was seen sticking out of the 'V' in the tail cone which permits the rudder spar to move through its arc of travel.

The pilot's suspicions were aroused, and when the two rear fuselage inspection panels were taken off, the material shown in the accompanying picture was removed from inside the fuselage. It was a nest made of a coarse grass and thick stalks of a local thistle, and contained three large eggs. The nest was built around a control pulley on one of the elevator cable runs.

It is doubtful on this occasion whether loss of control would have resulted if the aircraft had been flown before the nest was removed, but the sheer bulk of material, situated in the critical position in which it was found, was a potential control hazard. Had any wire been present in the nesting material, as sometimes occurs, this could have placed the aircraft in grave jeopardy.

So, be on the alert for birds nesting in your aircraft. A less vigilant pilot might have missed the evidence, and, had control of the aircraft become difficult during flight, the bird's eggs might not have been the only things broken!