AUSTRALIA

Aviation Safety Digest

ASD 139

SUMMER 1988/89

CIVIL AVIATION AUTHORITY

Aviation Safety Digest is prepared by the Civil Aviation Authority and is published by the Australian Government Publishing Service. It is distributed to Australian licence holders (except student pilots), registered aircraft owners and certain other persons and organisations having an operational interest in safety within the Australian civil aviation environment.

Distributees who experience delivery problems or who wish to notify a change of address should contact:

*The Publications Distribution Officer (EPSD)
Civil Aviation Authority
P.O. Box 1986, Carlton South, Vic. 3053, AUSTRALIA
Telephone (03) 667 2733*

Aviation Safety Digest is also available on subscription from the Australian Government Publishing Service. There is a subscription form in this issue. Inquiries and notifications of change of address should be directed to:

*Mail Order Sales
Australian Government Publishing Service
G.P.O. Box 84, Canberra, A.C.T. 2601, AUSTRALIA
Telephone (062) 95 4411. Telex AA62013*

Subscriptions may also be lodged at Commonwealth Government Bookshops in the capital cities.

The views expressed in the Aviation Safety Digest are those of the editor or the individual contributor and are intended to stimulate discussion in the fields of aviation safety and related areas. They do not necessarily reflect the policy of the Authority. The articles are intended to serve as a basis for discussion and even argument in an effort to identify and resolve problem areas and potentially hazardous situations.

Unless otherwise noted, articles in this publication are based on Australian accidents, incidents or statistics.

Reader comments and contributions are welcome but the editor reserves the right to publish only those items which are assessed as being constructive towards flight safety.

Reader contributions and correspondence should be addressed to:

*The Editor,
Aviation Safety Digest
Civil Aviation Authority
G.P.O. Box 367,
Canberra, A.C.T. 2601, AUSTRALIA*

*ISSN 0045-1207
R85/979(10) Cat. No. 87 1577 8*

*Printed by Ambassador Press Pty Ltd
51 Good Street, Granville, N.S.W. 2142, AUSTRALIA*

Contents

Editorial

YOU said . . .

We would like to thank those readers who took the trouble to complete and return the reader survey which was included in the *Aviation Safety Digest* last year.

Surprisingly, however, we only received 61 returns from a distribution of over 40 000. This may be accounted for by the comment offered by one respondent on a photocopy of the survey page; 'I don't like cutting up my Digests'. Either that or we could assume that over 39 900 readers reckon we are getting it right!

Despite the small return, the comments covered a total cross-section of views. Generally, with only one or two exceptions, readers found the format, timing and style quite appropriate. The comments we received about the content and emphasis of articles were the areas where readers disagreed significantly. Private pilots supported the current balance and thrust of articles where the professionals within the industry and those involved with other aspects of aviation want to see changes to cater for their particular needs.

We agree. The *Digest* has to cater for a total cross-section of people within the industry. Therefore, from the next issue you will see some changes. There will be at least two articles which will specifically address subjects of interest to the professionals, an article on airworthiness and one concerning overseas RPT accidents. We also intend to include a regular quiz so that you can test your 'air mindedness'.

The most common comment we have received in letters and face-to-face, when the Division has been in attendance at joint CAA/AOPA Pilot Safety Seminars or Airshows, is that readers miss the summary of accidents. This section of the *Digest* was always provided by the Bureau of Air Safety Investigation and now that the Authority has been established and BASI remains as a part of the Department of Transport and Communications, the Bureau is producing its own Journal which we are distributing for them with the *Digest* every quarter.

The *ASD* has been in constant production since 1952 and has always been considered an important element in the enhancement of aviation safety. The CAA will continue to ensure it meets the needs of the day and welcomes your views.

*TERRY WALLS
SAFETY PROMOTION SECTION
AVIATION STANDARDS DIVISION*

Covers

Front. Unique — the only Slingsby T66 Nipper currently flying in Australia. Owned and flown by Trevor Wright at the annual Prairie, Vic. fly-in during September 1988.
Photograph by Steve Small
Mamiya RZ67 Fujicolor

Back. View from the seat many would aspire to — state-of-the-art displays in the Coles-Myer HS 125 — 700B.
This photograph by R Ban Semer was an entry in the last Nikon ASD Photographic Competition.

Editorial Assistant: *Karen Hutchison*
Graphic Design: *Lesley Boulton*

Photographs: *P5* *Mike Griffin*
P8 *David Larkey*
P17 *Scott Allen*
P20 *BASI*

Diagrams: *Soussanith Nokham*
Kathy Walter

Cartoon: *Soussanith Nokham*

Dust devils

Bureau of Meteorology

DUST DEVILS are small-scale wind circulations that occur in the arid inland parts of Australia, generally in the hotter months of the year. They are generally visible as mini-tornadoes that draw up dust into a swirling cloud-like formation; however the wind circulation may be present without visible evidence, and these type of dust devils are especially dangerous. These latter types of dust devils often occur over grass, or soil 'sealed' with recent rain.

Dust devils may move at speeds of up to 30 knots, but they may stop suddenly, restart or change direction suddenly.

Conditions for formation

The prerequisites for visible dust devils are a source of dust, steep lapse rates, high surface temperatures and usually light winds within the boundary layer. The dust must be loose, although not necessarily thick; the dust devils may occur where sparse vegetation and scattered trees are interspersed with areas of no trees or grass. Dusts devils are seldom seen over salt marshes, well-watered grasslands or thick forests; small dust devils may occur in the monsoon forests over Arnhem Land.

Given fairly light winds in the boundary layer, strong surface heating and the establishment of a steep lapse rate cause very narrow columns of rotating air or whirlwinds to form; these interact and tease the soil particles as they pass over a dusty surface. These are lifted, transported and eventually dumped. In the process the particles are sifted, with the lightest falling last. As a dry period of weather persists, the top soil takes on progressively a more talc-like texture, ultimately the increased availability of fine 'talc' allows dust devils to become more spectacularly visible.

In general the dust devils are larger, higher and longer-lived when the temperature is higher and lapse rate steeper. In the Alice Springs area small dust devils with diameters less than 10 feet, height less than about 10 feet agl and life span less than two minutes may occur with temperatures in the range 18 to 28 degrees. With temperatures in excess of 35 degrees the diameters may range from 30 to 100 feet, with heights up to 10 000 feet agl and life spans up to 30 minutes longer.

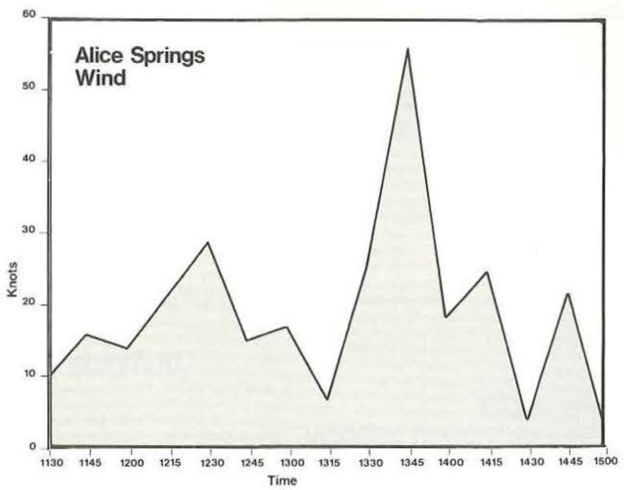
Particularly long lived dust devils (in the order of one hour) have been observed in the flat vegetation-sparse areas such as the Nullarbor and the north of South Australia.

An active meteorological system such as a trough evident on Mean Sea Level charts may cause the dust devils to be larger and also leads to marked visibility reduction in haze.

Hazardous nature

Dust devils, whether visible or not, are a hazard to aircraft especially during takeoff or landing. Because the background wind is generally light they produce a sudden impact when landing or taking-off. They have their greatest energy near the ground when the pilot's attention is concentrated on flying the aircraft, rather than watching for evidence of whirlwinds. At higher levels their dangers are generally less, but there is the risk of loss of control. This risk in flight is greatest near the upper part of the disturbance where the rising column of air changes its structure by spreading. At this level the aircraft's lift can be affected, resulting in sloppy control responses.

There is often difficulty in accurately gauging the distance to or from a dust devil because there is very little scale reference available.



Record of surface wind observation, Alice Springs airport, 23 October 1987, showing a gust of 55 knot coincident with a dust devil passing over the observing instrumentation.

Suggested flying techniques and visible clues

Pilots who fly daily in dust devil prone areas adopt appropriate procedures to minimise their impact. To a pilot who has gained experience in coastal areas, the first encounter with a dust devil can be frightening. For such pilots the following advice is offered:

- Delay takeoff and landing until the airstrip is clear.
- At operating levels try to avoid going anywhere near dust devils.
- To minimise encounters, whenever possible confine flying to morning hours.
- Watch tall grass movement when landing; this may provide an indication of any invisible dust devil.
- Avoid by at least 2000 feet the region above a dust devil.
- Always make a powered approach in areas of dust devils.

In dust devil prone areas light aircraft should be securely pegged down if not parked in a substantial hanger.

Some pilot experiences of dust devils from Aviation Safety Digest No. 101, 1978.

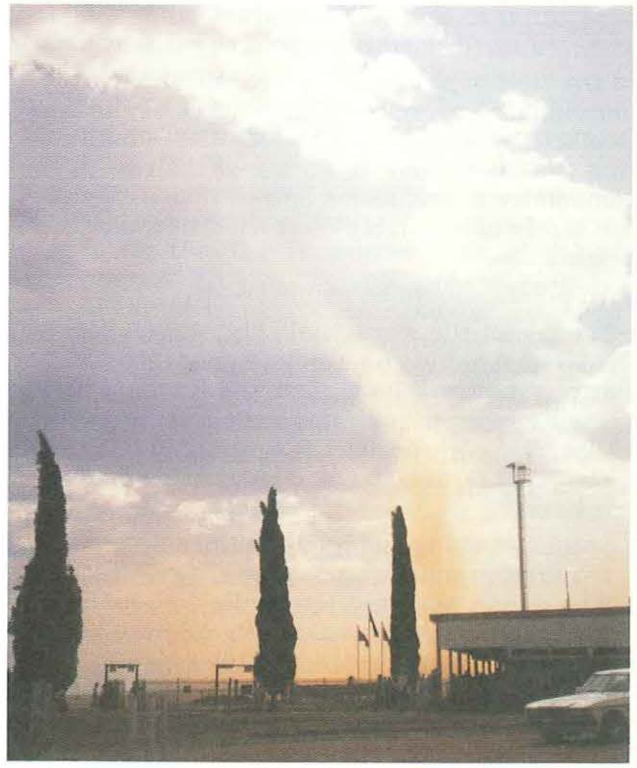
A pilot was flying a Cessna 172 in the Cunnamulla area at 10 000 ft in the cloudless conditions. The surface temperature was above 38 degrees C and the wind light and variable. No dust devils were visible at the cruising level, but many could be seen below. The aircraft was heavily loaded, with the pilot's wife and three children as passengers. The pilot believes he flew into the invisible top of a cauliflowering dust devil: 'In spite of full corrective control and full power,' he recounts, 'the aircraft rolled inverted and was flown out underneath. I could not climb any higher and was forced to descend to maintain control'.

At Nanda an aircraft was landing into a gusty wind of 20 to 30 knots. Small numbers of scattered dust devils were visible and the surface temperature was about 38 degrees C. 'At the last moment,' the pilot relates, 'a dust devil several hundred feet high crossed the landing path, slewing the aircraft first one way then the other, and rolling it on to each main landing wheel alternately. The whirlwind was one of a group of three, and was invisible until it moved on to an ungrassed area and picked up dust. At one point the aircraft was lifted clear of the ground at or just below stalling speed — very unpleasant!'

At Richmond, a Cessna 150 was taking off in almost calm conditions. The temperature was 41 degrees C and the sky was cloudless. At a height of about 100 feet it encountered a whirlwind. (The pilot believes this was in the process of forming at the time — it was not visible as he was taking off but it later became a very large dust devil.) The pilot's first indication of the encounter was a very sudden gain of about 200 feet in height. But then the upward motion stopped so suddenly that the pilot was flung against the restraint of his seat belt and bumped his head against the cabin roof. At the same time the airspeed indicator needle shot up into the red arc! Though buffetted, the aircraft remained controllable. The pilot considers the only real danger was the effect of the gust on the aircraft's structure as the airspeed indicator showed an increase of some 60 knots. Had the whirlwind been fully developed, he feels that structural overloading could have resulted in airframe failure.

Another pilot said he had seen the roofs of two houses at Richmond lifted by dust devils and the sheets of galvanised iron carried half a mile. He believes that light aircraft would certainly be lifted if not pegged down. On one occasion a Cherokee six tied down at Windorah with four 16mm diameter ropes was tipped on to its back when a whirlwind snapped two of the ropes. Another pilot told of a Piper Colt which had just been wheeled from a hangar in the course of a 100 hourly inspection. Before those pushing it had time to walk back into the hangar, a whirlwind had struck the aircraft, picked it up and dropped it again upside down, damaged almost beyond repair ☐

Alice Springs airport. Possible small tornado associated with a trough and large cumulus.



Exams — why bother?

by Graham Smith

PEOPLE HAVE been flying aircraft for over 80 years and in previous times, pilots did not have to pass all of the examinations that are currently required. Anyway, why can't all the theoretical bits be tested during the flight test? Aren't the exams just another way of giving more public servants a job?

The basic function of any licensing system is to grant privileges to selected individuals. This of course means that some people will be approved to have these privileges and others will be excluded. In fact it becomes illegal for those to practice the particular activity. This applies to tradesmen where certain trained and skilled people only are permitted to install or modify electrical wiring or plumbing. It applies to vehicle drivers — and it applies to people engaged in aviation either as licensed maintenance engineers or pilots. A minimum standard of training, knowledge and technical skill is a prerequisite for those people to have the privilege of holding a licence — and in all cases some means of testing that knowledge and skill is required so that the individual can be assessed as fit or unfit to hold that licence.

In the case of aviation, we are authorising the individual to exercise the privileges of the particular licence in such a way that it is unlikely that the safety and well-being of the rest of the community is prejudiced and so that passengers are safely and reliably conducted to their destination.

Two points should be emphasised:

- The use of the word, 'unlikely' is well considered. There is no absolute guarantee that any system will be perfect and it would be unduly restrictive to make the tests so severe that only a very select few can gain a licence. The legal term is 'beyond reasonable doubt' I believe.
- Specialist skills and qualifications are required to pilot an aircraft safely. Persons who do not possess those skills and qualifications may not pilot aircraft. Additionally not all persons who wish to pilot aircraft are capable of achieving the skills necessary to ensure that the rights of other members of the public are protected.

The Australian Government has charged the Civil Aviation Authority with the task of ensuring safe air navigation, and has specifically empowered it to utilize licensing of aircraft pilots as one means to achieve that objective. Along with all other ICAO States the Authority has established control mechanisms governing the qualifications of pilots, and uses eight measures to assess the suitability of persons to pilot aircraft —

- Citizenship.
- Medical standards.
- Language qualifications.
- Age.
- Aeronautical knowledge.
- Aeronautical experience.
- Aeronautical skill.
- Recent experience.

Testing methods

There are several different methods of testing a candidate's suitability against each of the above criteria. Arguments can be mounted for and against the methods used by the Authority. For example the value of measuring blood pressure in a doctors surgery instead of in the cockpit during periods of high workload is questionable. It can be argued that vision standards could be adequately tested during operations, and hence the 'artificial' standards to be met during the present remote testing can unfairly restrict an individual. The same can be said about audio standards. The rationale for using age as a measure of mental and physical maturity is also open to debate. And for how much does aeronautical experience count? Why isn't demonstrated ability alone enough? Flogging around familiar terrain just to accumulate command hours or to 'gain' navigational experience can be regarded as a rather futile exercise.

However all ICAO States utilize the same criteria and similar techniques as Australia to 'ensure' safe air navigation. No State has been able to derive any dramatically different methods.

One reason for using remote testing of pilot qualifications is administrative efficiency. There is no doubt that all of the criteria could be measured adequately in the cockpit. But the cost of doing so, for several thousand pilots each year, would be prohibitive.

Standards

The determination of acceptable standards is another aspect which all regulatory authorities find difficult. Should the hearing standard for a pilot flying jet aircraft be the same as for one flying a twin-piston? Should all pilots be able to flight plan in 30 minutes? Should PPL holders be required to demonstrate proficiency under the hood or be able to use the VOR? There are no clear cut answers to these questions, and the problems are exacerbated when remote testing techniques are employed.

Testing knowledge

And so to testing aeronautical knowledge in formal written examinations in an environment remote from the aircraft.

Three groups of aeronautical knowledge are widely recognized —

- Must know.
- Should know.
- Could know.

The difficulty of determining the elements in each of the groups is increased by the rapid changes in aviation technology. As in all fields of scientific endeavor, aviation technology is changing at an enormous rate. What seems to be relevant to today's operational techniques is irrelevant to tomorrow's. Perhaps a poor example but one which illustrates the point is the advent of the ADF. Most of us have never used a radio compass which required the loop to be rotated manually. Nowadays, just switch it on, identify the station and the needle point to the station! Beauty! Automatic ! But did you realize that there's a reason why it's called an AUTOMATIC Direction Finder? It wasn't always so easy. A manually rotated loop required a different knowledge standard — higher in fact.

Assuming that we have established the items of knowledge required, we can start thinking about pass standards. Surely the 'must knows' have a pass standard of 100%. Anything less must be unsafe. Right? Right! But are we confident that we can demand 100% in a remote (or simulated) environment? And if not 100% then what? And what about the poor candidate who works right through the problem until the last line, but then makes an arithmetical mistake and 'loads' far too little fuel for the overwater flight?

Now what about the 'should knows'? Why are they 'should knows' and not 'must know'? What purpose do they serve? Opinions around the world differ markedly. Perhaps the most widely accepted argument is that after a pilot has complied with the prescribed procedures, and hence he should know because they enable him to improve the efficiency of his operation. One example might be the effect of wind on specific ground range. Not important for many flights but nevertheless it may have a bearing on others.

The 'could know' items are less well defined again. Perhaps they give the pilot a sense of command of his operating environment, and consequently impart some 'emotional security'. The biggest danger in this area stems from pilots believing they know more than they do: a little knowledge can be a dangerous thing.

Recency

The need for recent experience is readily accepted in the area of aeronautical skill. The argument is not so readily accepted for aeronautical knowledge. The Biennial Flight Review calls up a review of aeronautical knowledge and perhaps this is adequate. Knowledge deteriorates with time and a bit of a brush up now and again doesn't do any harm. Some other areas for which a recent demonstration of knowledge should perhaps be demanded and which are not so obvious are progression to a higher licence level, IFR pilots operating VFR after a long break from VFR ops, and airline pilots operating OCTA again after a long break from that environment. At the present moment there is no formal testing required for the later two transitions. Regarding up-grading licences, testing of all the knowledge applicable to the lower level of licence would require a very long exam.

CPL

No discussion of written examinations as a method of testing aeronautical knowledge would be complete without some mention of the CPL (Aeroplanes) examination structure. The Australian system is unique, but is not likely to be for much longer. At least two countries are interested in the system. The provision for candidates to prove their proficiency in the elementary concepts (elementary does not mean 'easy', but rather 'constituent') before being confronted with the compound and complex task of planning a commercial operation is proving a boon to both candidates and the Authority. At the time of going to press, there had only been one exam series where the pass rate was less than 50%. This is in stark contrast to the situation of the previous system where pass rates of 25% were common. However the system is still far from perfect. Until now the Final Exam has only been available at three scheduled sittings per year, and it is something of a milestone that the availability was increased to 'on demand' from October 1988 — would it be in order to say that this is another Bicentennial Achievement? This will complete the transition from all exams being available only on a scheduled basis to all exams being non-scheduled — the change-over having been accomplished in less than four years. The last step in the CPL system will be to streamline the subjects and exams as discussed above. Hopefully this will result in a substantial reduction in the number of multi-choice exams.

The challenge of determining appropriate flight crew standards, more accurately defining the role of aeronautical knowledge, and the most efficient method of testing that knowledge, will forever be with us. Meanwhile think about what you know and note where and when you have been uncertain what to do. Maybe the uncertainty was due to a lack of knowledge □

Life jackets

THE AIRCRAFT had just taken-off and was cruising at 1000 feet over the water. At this point the pilot noticed a change in the engine note and turned back towards the strip. The engine was now running roughly and the power output reduced to zero. A ditching was inevitable.

The landing on the water was successful and the aircraft floated in a sixty degree, nose-down attitude. Water began to enter the cabin through the broken windscreen.

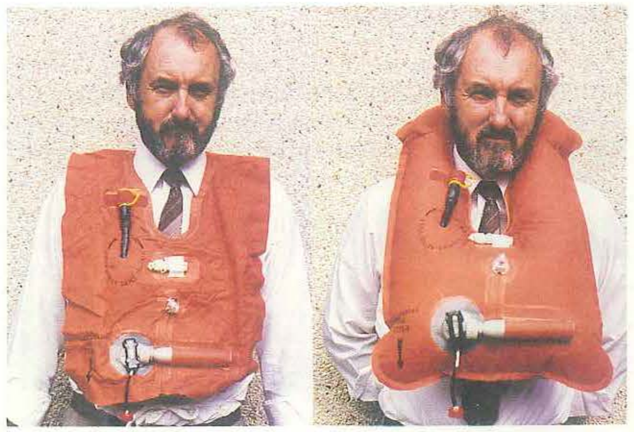
The four passengers escaped through the right-hand door and the pilot through the left window.

After clinging to the aircraft for a short time, they all decided to swim for shore — a distance of about two kilometres.

They were all subsequently picked up by a rescue boat.

The aircraft sank after about fifteen minutes.

None of the occupants were wearing the life jackets that were provided and which were required to be worn by the company's operations manual.



The recent ditching near Outer Harbour in South Australia ended in more tragic circumstances — one of the occupants swam for the shore and was never found. Again no-one was wearing life jackets even though this flight had just crossed St Vincent's Gulf.

It seems stupid to say that the requirement to wear life jackets was framed to protect the pilot and passengers of the aircraft — not to make them uncomfortable. It's not always possible to fly at an altitude that keeps you within gliding distance of dry land and the risk of having to ditch may be low — but it's hard to explain to grieving relatives that their kin drowned, especially in some cases, while there was a perfectly serviceable life jacket in the baggage compartment □

Medium-rare and well-done

THE AIRCRAFT was being ferried to Waikerie for a major inspection. The weather was not a problem and the aircraft was cruising at 2500 feet.

The pilot had owned the aircraft for about six months and had been operating from his own property.

As he was cruising along he became aware of a hot, oily smell. He turned off the heaters and checked the engine gauges. Indications appeared normal although the oil temperature was on the high side of the green sector.

Then oil started streaming up the windscreen. The pilot immediately closed the throttle, declared an emergency and picked a paddock for a forced landing.

He turned the aircraft left and made a straight-in approach. Although the engine was turning normally he made a glide approach and on final, turned the switches off and pulled the mixture to idle/cut-off.

The aircraft touched-down normally and the pilot braked as quickly as possible.

As the aircraft came to a stop the pilot noticed smoke billowing from the engine area. As the aircraft stopped rolling he grabbed the extinguisher and exited by the rear door to avoid the smoke that was now billowing from the engine. He opened two fasteners on the engine cowls and emptied the contents of the extinguisher into the compartment.

It had no apparent effect and fearing that the aircraft might explode, the pilot grabbed his overnight bag and ran up the hill to the south.

As he passed the 100 metre mark, the engine fell forward from the airframe and the tail settled onto the ground. Within a further two minutes, the cabin was ablaze.

The aircraft was destroyed by the fire.

The damage was so severe as to prevent any reliable assesssment of the cause of the fire. Fortunately this type of occurrence is medium-rare and this pilot's response was well-done □

ILS — Some whats and whys

by Captain John Edwards, Airways Surveyor, Civil Aviation Authority

THIS ARTICLE is not intended to describe how to fly an ILS in a particular aircraft with a certain instrument fit, but rather, to identify with justification some of the features of the operational environment that are required because of an ILS. The article will also discuss some of the less well understood features of an ILS procedure. The need for the article is that much of the relevant material is not conveniently collated under one cover with the result that it is a constant source of reasonable questions — references are provided at the end of the article.

The operational environment

The category of ILS operation has a direct bearing on the requirements of the operational environment provided, as does the geometry of the installation relative to the movement area. Therefore every installation will not necessarily attract each feature discussed in the following paragraphs.

Multipathing

Multipathing (1) occurs when an ILS localizer or glidepath signal is reflected from a surface not associated with the ILS installation. The result is an additional unplanned signal path from the transmitter to the airborne receiver. If the receiver is unable to detect and discriminate against the false path, the input to the pilots indication will be corrupt. The likely indication will be a needle fluctuation, sometimes for a number of seconds. In bad cases, the 'OFF' flag may activate momentarily. Such occurrences may cause an autopilot to disengage.

During some phases of an ILS approach, such as approaching the DA, or during a procedure's autoland phase when the aircraft is below the category 1 DA, it is unacceptable to have the ILS signal corrupted by avoidable events. At other critical stages of an ILS, avoidable corruption is extremely undesirable as it can cause pilots unnecessary concern about the serviceability of the ILS to the extent that approaches may be aborted.

Sensitive and critical areas

In order to minimise multipathing from transient sources, such as aircraft, vehicles etc, areas around each transmitter are assessed and critical areas and sensitive areas are declared. The critical area is in the immediate vicinity of the antenna and must be kept free of transient multipath sources during all ILS operations. The sensitive area surrounds the critical area and must be kept free of larger transient multipath sources during the more critical phases of ILS operations. The most likely sources of infringement of theses areas are:

(a) Glidepath. Aircraft taxiing for takeoff and passing in front of the antenna, and

(b) Localiser. Landing aircraft during roll-out and while taxiing away from the immediate runway area, and aircraft overflying the antenna during takeoff.

Operational procedures (SMC and vehicle control) are used to prevent unauthorised penetration of these areas. However, pilots need to be able to identify the areas to prevent unauthorised and inadvertant penetrations. The internationally approved means of marking critical and sensitive areas are:

(a) Day. By marker boards or holding points (2), (3), and

(b) Night. By having the taxiing centreline lighting within the area displayed as alternate green and yellow lights (4) and/or marker boards and holding points (2) and (3).

We should recall the AIP RAC/OPS-0-40 defines conditions which cause aircraft to be of concern as sources of multipath interference in sensitive areas.

Monitoring

Susceptibility to multipathing means that ILS is a navigation aid that can be serviceable but which may present to a pilot as being unreliable. This is one of the reasons that ATC is required to have real time monitoring of the ground installation. This enables a pilot who experiences brief interference to the ILS and who is unable to identify the likely source as an aircraft movement, to quickly check that the ground equipment is indicating normal operation. ATC also need to know as early as possible of the failure of an ILS component as a likely outcome is an immediate requirement to re-organise traffic.

Holding points

The discussion on multipathing explains why ILS holding points might be established around the roll-out end of an ILS runway and near the approach end in the vicinity of the glidepath antenna. However, ILS operations may also require the establishment of holding points around the first 1200 m or so, of runway to ensure that aircraft on the ground do not present an obstacle to aircraft that execute a missed approach from the DA (5). Holding points established for this reason are usually further from the runway than many pilots may expect as the norm and, in fact, a need may arise to establish these points along parallel taxiways. These holding points are nearly always required where category 2 or 3 operations are authorised.

Localiser width

Many pilots will have found some localisers to be more sensitive than they expect. The reason is that contrary to widely held belief, localisers are not installed so that they all have the same angular displacement for a given sensitivity, ie a dot on the pilots indicator does not represent the same number of degrees on all localisers. This is brought about by an operational consideration which is that the pilots chance of landing off an ILS should not vary between installations, ie, at the threshold the aircraft's displacement from the centreline should be the same on all runways for a given indication in the cockpit. The advent of autoland made this consideration a requirement. Therefore, localisers are installed so that normally they all have the same width at the threshold (6), Figure 1 refers. Consequently localisers on longer runways will be narrower at the markers and considerably narrower at the outer locator. Assistance in overcoming localiser intercept problems is provided by lead radials and bearings and is described later.

Marker beacons or DME

The normal ILS installation requires the provision of marker beacons (7). DME may be provided in lieu of markers (8) but only where the provision of a normal system is impractical and then only in accordance with strict frequency pairing (9) and geometrical (10) requirements. Markers are superior to DME in that they provide the pilot with independent and preset audio and visual reminders that he has reached a point on the procedure where certain parameters must be confirmed or actions taken if the safety of the procedure is to be assured. By comparison, DME information is passive and, therefore, must be actively sought by the pilot to provide a similar service. Consequently, a pilot who is distracted during an ILS/DME could easily miss a significant safety check-point.

The purpose of the marker beacon is:

(a) Outer marker, to enable the pilot to conduct an altimeter/glide slope validity check (11),

(b) Middle marker, to warn of the impending arrival of minima (12), and

(c) Inner marker, to warn of the impending arrival of the threshold (13).

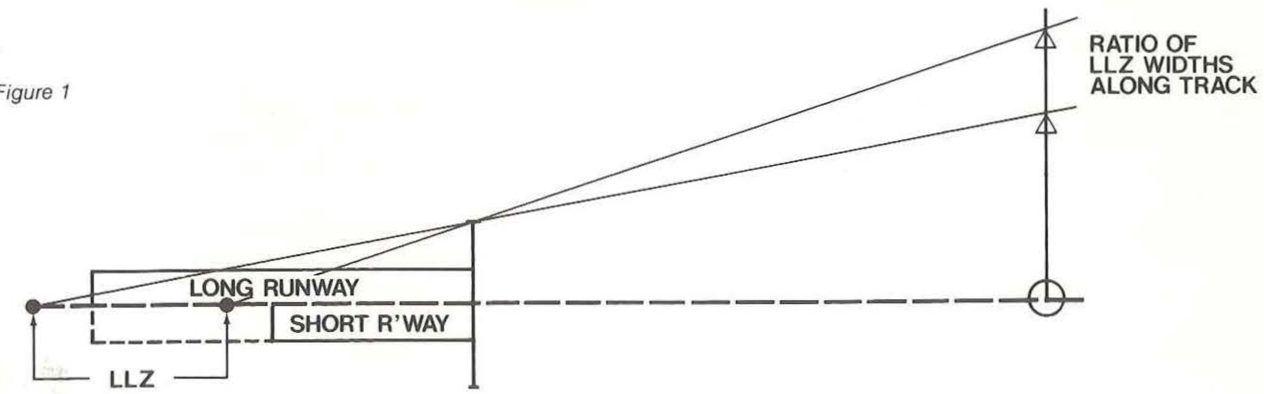
The outer marker allows the pilot to compare the 'on slope' altimeter reading with the pre-calculated trigonometric information calculated by the procedure designer and provided on the approach chart. Any difference will only have its source in variation in the atmospheric conditions from those assumed by the procedure designer (usually ISA), an altimeter malfunction (misset QNH or mechanical failure) or a glideslope failure that has not been detected by the ILS monitors.

The role of the middle marker has changed subtly with the acceptance of the aircraft category concept and the potential for various categories of ILS operation to be flown on the same installation. The marker would be positioned a long way from some minima points if it were sited to satisfy the highest possible minima. Therefore, in Australia the middle marker is usually sited near the category 1 minima points (5) and, for the pilot, receipt of the marker signal means that he should have made or should be making the decision to continue the approach or to execute a missed approach.

Procedure design

An ILS procedure is designed using non-precision techniques up to the final approach fix (FAF) or, if a fix is not specified, the final approach point (FAP) and for the missed approach usually after the procedure reaches a height of 1000 feet. This means that even though the pilot may acquire, and navigate by reference to he glidepath before the FAF/FAP, the safety of the aircraft is only assured if he complies with the descent limits and fixes that define these segments. Because the tolerances associated with the glidepath exceed those required by non-precision techniques at ranges in excess of 3 nm from the threshold, a pilot who chooses to fly the glidepath at the expense of other descent limits may place his aircraft in jeopardy. In other words precision techniques are only used to ensure obstacle clearance for a very small part of an ILS procedure.

Figure 1



LLZ WIDTH AT THRESHOLD

Temperature error correction (14)

Altimeters are calibrated to read correctly in ISA conditions. When a pilot sets QNH, he applies a correction for both the pressure and temperature variation from ISA conditions at the QNH datum. (The QNH datum is the place where the meteorological readings are taken, usually the aerodrome in Australia). Unfortunately, the QNH corrections are only correct at the datum. Consequently, as height above the datum increases, so does the magnitude of these errors in the indicated altitude, but with the origin of the error now the datum rather than mean sea level, Figure 2 refers.

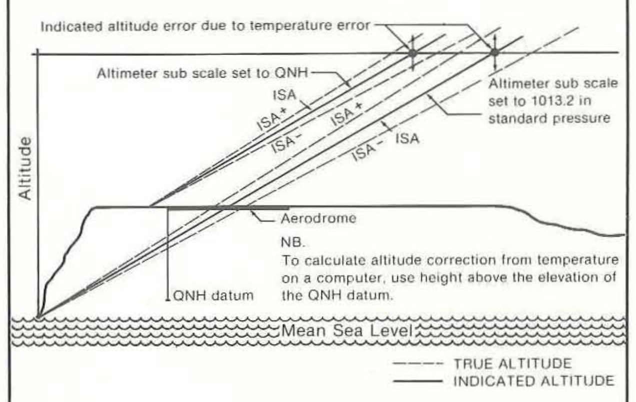


Figure 2

The pilot does not have the means, or in most cases the time, to determine the exact magnitude of altimeter error due to temperature variation from ISA. Even if he could, it would be unwise to apply the value in a simple additive fashion as it is not the only factor assessed in the procedure designers obstacle clearance values and, these factors are not usually combined by a simple additive method. However, temperature variation can achieve a disproportionate significance. Therefore, to ensure a safe operation AIP-DAP page 2-11, para 2.9 requires the minima to be increased when temperatures are less than ISA. However, the same section of DAP prohibits reduction of descent limits in the same way for the reasons given above.

AIP-DAP has no requirement to adjust descent limits encountered before the DA or MDA or the lowest holding altitude, rather, the need for such precaution is a judgement left to the pilot. The reasons for this are that Australia does not experience the extremely cold air masses common in Canada for example, and this means that in Australia the most significant variation from ISA will be near the surface and, consequently, near the DA/MDA where obstacle clearance protection is least tolerant of distorting effects. However, pilots who assess cold weather conditions as justifying corrections that increase the lowest holding altitude and intermediate descent limits are free to do so but not without notifying ATC of their required altitudes as such changes could affect separation with other traffic. Pilots operating in some overseas areas would be well advised to make these additional corrections as a matter of course.

Therefore, during preparation for an ILS the pilot should receive the ATIS, assess the temperature effect on the DA and determine the value that he should use, and assess the effect on the outer marker crossing altitude and determine the expected indicated altitude at the marker.

Application to outer marker checks

The effect of temperature variation from ISA on the indicated altitude shown during an outer marker check should be understood. Because the pilot is flying the glidepath, he needs to apply the temperature correction to indicated altitude in the opposite sense to that used when determining minima and descent limits. Therefore, the pilot who is 'on slope' on a hot day can expect a low indicated altitude at the outer marker and the reverse for cold conditions. An example of the magnitude of this effect combined with other factors is given in AIP-DAP page 2-11 para 2.8.

Lead radials and bearings

Earlier discussion identified the potential for narrow localisers. If a pilot who is intercepting a narrow localiser waits for the localiser bar to become active before initiating the turn on, he may be unable to avoid overshooting the localiser. The same effect may occur if the localiser intercept angle is too large. The procedure designer can assist the pilot by providing a lead radial or bearing. These lead radials/bearings are nominally 2 nm before the localiser course and are points where the pilot may initiate the turn so as to avoid overshooting the localiser during the intercept. The DAP legend shows how lead radials/bearings are depicted.

Missed approach initiation and height loss

The DA/DH is the latest point at which the pilot must initiate the missed approach (15) by the most effective means (16) if the pilot has decided against continuing to land. This means that the decision to continue or not, is taken before the arrival at the DA/DH. This strict definition is necessary so that both pilot and procedure designer have a common understanding which then allows the designer to apply height loss values to the DA/DH. These values are to protect the aircraft during the initial missed approach when the aircraft will sink below the DA/DH. The values used are in the table over (17) and were determined from observation of normal operations.

AIRCRAFT CATEGORY (V_{at})	MARGIN USING RADIO ALTIMETER		MARGIN USING PRESSURE ALTIMETER	
	METRES	FEET	METRES	FEET
A 169 km/h (90 kt)	13	42	40	130
B 223 km/h (120 kt)	18	59	43	142
C 260 km/h (140 kt)	22	71	46	150
D 306 km/h (165 kt)	26	85	49	161

The difference between the radio altimeter values and the pressure altimeter values are the inaccuracies associated with pressure altimeter. Therefore, the radio altimeter values are essentially those associated with the aircraft. However, these values are intended to protect all aircraft. Therefore, pilots wishing to assess the legitimacy of their recovery technique should use a third of the radio altimeter value in the table above as the value achieved by 50 percent of all such operations and two thirds of the radio altimeter value as protecting 95 percent of all operations. However, these values will suffer a further slight reductions if read from a pressure altimeter owing to altimeter lag.

Readers should remember that determination of DH by radio altimeter is not normally authorised for other than category 2 or 3 operations because of the environment preparation and controls necessary to ensure the necessary level of confidence in the procedure.

CAR 257

CAR 257 prohibits a pilot continuing an approach 'when any element constituting the meteorological minima for landing is less than that determined for that aerodrome except in the case of an emergency'. This CAR prevents a pilot proceeding to the minima to 'look and see' if he can land. This seemingly conservative restriction recognises that the missed approach is not designed with protection that permits its use as a normal event (as distinct from the comparatively infrequent use it should get from operations conducted in accordance with the CAR). In the case of the precision segment of an ILS the segment is designed with the following safety objectives:

(a) Overall risk of collision with obstacles 1×10^{-7} (18)

(b) Missed approach rate 1×10^{-2} (19)

The CAR recognises the above and is intended to ensure that pilots of aircraft which are permitted to proceed to the minima enjoy a high probability of being able to land off the approach. (NOTE: International assessment has been that the criteria necessary to protect the missed approach risk equal to the normal event, most likely would incur significant operational penalty).

CAO 40.2

CAO 40.2 requires the pilot to be positioned at the minima so that he may 'land without undue manoeuvering'. This requirement recognises:

(a) the concerns of CAR 257 and the need for aircraft permitted to the minima to have a high assurance of completing a successful landing,

(b) That pilots who proceed below the DA/DH into the visual segment of the procedure and then execute a missed approach are doing so from a point below and in front of that assumed by the procedure design and, this may significantly reduce the design protection of the missed approach, and

(c) That the speed range at the minima differs between aircraft types so that all types are not equally sensitive to positioning at the minima.

The requirement calls for a subjective value judgement by examining officers but to do otherwise would not recognise the different capabilities of different aircraft types.

Conclusion

This article discusses some of the less well known features and less well understood facets of ILS operations. The discussion is intended to assist better pilot understanding. The references provide a more comprehensive discussion of the items. The ILS is an excellent navigation aid but like everything else in aviation it can be used a little more wisely and confidently with an improved understanding □

References

1. AIP RAC/OPS — 0 — 40
   ICAO Annex 10, Part 1, Attachment C para 2.1.10
2. ICAO Annex 14 para 5.4.2.3
3. ICAO Annex 14 para 5.2.9.2
4. ICAO Annex 14 para 5.3.16.4
5. ICAO Annex 14 para 5.2.10.2
   ICAO Doc 8169 — OPS/611, Vol 2, Table 21-2
6. ICAO Annex 10, Part 1, para 3.1.3.7.3
7. ICAO Annex 10, Part 1, para 3.1.2.1
8. ICAO Annex 10, Part 1, para 3.1.7.6.6
9. ICAO Annex 10, Part 1, para 3.1.7.6.6.2
10. ICAO Annex 10, Part 1, para 3.1.7.6.6.1
11. ICAO Annex 10, Part 1, para 3.1.7.6.2.2
12. ICAO Annex 10, Part 1, para 3.1.7.6.2
13. ICAO Annex 10, Part 1, para 3.1.7.6.1
14. AIP-DAP page 2-11 para 2.9
    ICAO Doc 8168-OPS/611 Vol 1, Table 3-4
15. AIP-DAP, 1-4
    ICAO Doc 8168-OPS/611, Vol 1, page 1-1
16. ICAO Doc 9274-AN/904 para 4.2.1
17. ICAO Doc 8168-OPS/611 Table 21-4
18. ICAO Doc 8168-OPS/611, Vol 2, para 21.1.4
19. ICAO Doc 8168-OPS/611, Vol 2, para 21.4.8.8.3.2
    ICAO Doc 9274-AN/904, Part 2, para 7.3.1

AIRFLOW

Feeling a little query?

The AIRFLOW column is intended to promote discussion on topics relating to aviation safety. Input from student pilots and flying instructors is particularly welcome.

Anonymity will be respected if requested. 'Immunity' applies with respect to any self-confessed infringements that are highlighted for the benefit of others.

Write to: AIRFLOW
Aviation Safety Digest
P.O. Box 367
CANBERRA A.C.T. 2601
Australia

AERONAUTICAL INFORMATION SERVICE AUSTRALIA

NOTICE

CURRENT DOCUMENTATION & PLANNED NEXT ISSUE

Document	Current Issue #	Planned Next Issue #
DAP(E)	20.10.88	15.12.88
DAP(W)	17.11.88	12.01.89
AGA 0-1-2	05.05.88	04.05.89
Aerodrome Diagrams	22.09.88	12.01.89
* ERS A	20.10.88	09.02.89'
AIP (book)	25.08.88	15.12.88
VFG (book)	25.08.88	15.12.88
AIP/MAP	30.06.88	15.12.88
VFG/MAP	30.06.88	15.12.88
DAH	30.06.88	15.12.88

dates quoted are effective dates

* New document replaces AGA 3 & AIP/ERS

NOTE: CLASS 1 & CLASS 11 NOTAM ARE TO BE CONSULTED WHEN USING ANY OF THE ABOVE DOCUMENTS.

ISSUE: 4
DATE: 01 NOV 88

Some like it hot

Bureau of Meteorology

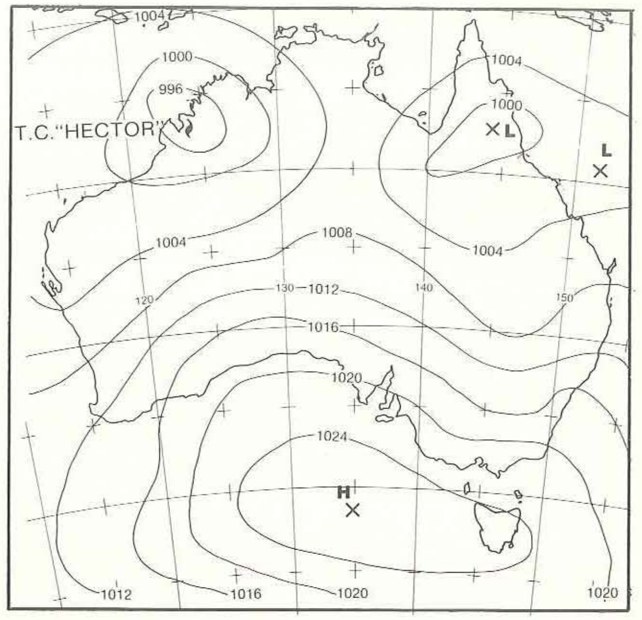
SUMMER FLYING conditions vary greatly throughout Australia. This article provides an overview of conditions in the tropics and some other parts of Australia; it does not include all the local variations which are often topographically induced.

The tropics

The 'wet' season in the tropics encompasses all the summer months and a variable period at either end. The 'wet' is characterised for most of the time by weak pressure gradients and hot, humid unstable weather conditions. Thunderstorms are almost an everyday occurrence at some locations with a diurnal peak in the late afternoon and evening. The frequency is greatest over the northwest Kimberley, the 'top end' of the Northern Territory, and inland Queensland between Normanton and Charleville.

Tropical storms are much larger in vertical extent than those experienced in temperate latitudes and often spread out to form sheets of altostratus and cirrostratus clouds towards the end of their life cycle, resulting in steady overnight rain and low cloud persisting in the morning. They also grow rapidly and the transition from benign to dangerous flying conditions can be dramatic.

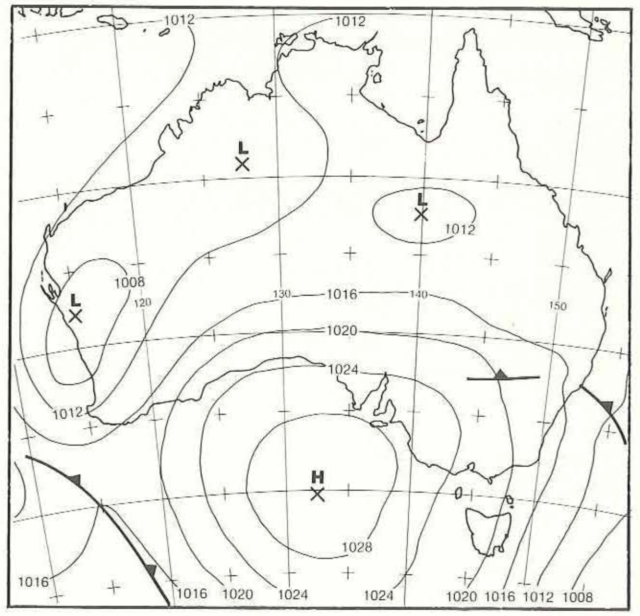
The onset of the northwest monsoon in earnest sees a change from the thunderstorm pattern to one characterised more by heavy stratiform rain. This is particularly so in the vicinity of the monsoon trough where the northwest winds from the equator meet the easterlies which predominate over continental Australia during summer months. Low stratus is a real hazard in this situation due to persistent heavy precipitation and overcast middle level cloud, and may persist around the exposed coasts and ranges for days on end. However, the mere presence of the monsoon trough does not guarantee this type of weather. The monsoon has active and quiet periods and the associated weather patterns can range between the two scenarios described here — the point is that almost every day during the wet season will produce weather conditions which are difficult, if not dangerous, for the unwary pilot. Careful scrutiny of the forecasts and, where possible, elaborative briefing are of paramount importance.



Southern Australia

Summer, with its long periods of clear skies over much of southern Australia, often presents the best flying conditions there. However the pilot must be conscious of:

- The moderate to severe thermal activity in the lower atmospheric levels that accompanies the high temperatures.
- The occasional thunderstorms that are usually high based, but nevertheless can cause severe downdrafts, heavy showers and hail.
- The reduced visibility that occurs when dust is raised from the dry surface.
- The high density altitude at elevated locations and its implications.
- Local topographic effects which are often magnified in summer.
- The relatively high incidence of low cloud and reduced visibility usually associated with showers and drizzle along the NSW and East Gippsland coasts and windward side of the ranges when an onshore stream prevails □



Benchmark safety

Setting some personal 'benchmarks' in our flying could go some way towards improving our safety record.

by Julian Johnson

SAFETY AND good airmanship are synonymous. But we all break the rules or do something stupid occasionally.

I've just been looking at general aviation aircraft accident numbers for 1986 and 1987. They make interesting reading only if you have a morbid fascination for statistical data. In bare bones terms, they tell us that there were 218 general aviation accidents in 1986 and 215 in 1987.

The experts say that, for general aviation at least, accident numbers have '...stabilized at a mean of 235 per annum, regardless of the number of hours flown'. In plain language that really means that our accident record has 'bottomed out' and, given essentially similar conditions, is not likely to vary much in the foreseeable future. Lest you should start feeling comfortable about that though, its worth knowing that some 8% of our accidents are fatal and result in the death of about fifty people every year. There's no room to be comfortable about that level of tragedy.

As well as being tragic, the individual accidents that make up our statistical record make good headline news. Technically uninformed though it may be, bad press is a powerful weapon in convincing the general public that flying light aircraft is a dangerous occupation, and such public view can, and often is, used as the justification for the imposition of more regulation and controlled airspace by our opinion conscious political masters.

Statistics also mean money. A Bureau of Air Safety Investigation study estimates that, in 1980 terms, the minimum annual cost of aircraft accidents to the community is $31 million. The cost of nearly everything we pay for when we go flying, from fuel, to insurance, to the actual price of the aircraft is, at least in part, a reflection of our safety record.

Reading the details of the individual accidents making up our safety record, its hard not to reach the conclusion that there are some pretty crazy people around. Perhaps, with the all powerful benefit of hindsight we may laugh a little, smugly confident that we would never personally get ourselves into such a situation. But in truth there's probably few of us who could not say '. . . there but for the grace of God go I'. In truth, every one of us can probably recall a time in our personal flying when we have broken the rules or displayed abominable airmanship.

One school of thought has it that only by flying close to the edge is it possible to build the experience necessary to become a fully competent pilot. Another that aviation, whilst not in itself inherently dangerous, is simply more unforgiving of error than many other forms of activity. Whichever way you look at it though, it would appear that most malfunctions occur in the front left seat and that they could in many instances have been easily avoided by better decision making. Human nature seems to promote a view that perseverance will be rewarded with survival.

Think of it in terms of driving your car. There are a good few times when we are faced with the decision to stop as a traffic light turns amber at an intersection, or press on, trusting to speed and bravado to get us through before it turns red. A nervous glance in the rear view mirror, a silent 'phew!' and we are on our way. Was it a good decision? Well — in hindsight perhaps not, but we survived didn't we?

And the same is true in flying, at least to the extent that we are required to make many decisions — some of which will be wrong. Wrong because it is an undeniable human trait that, by definition, some decisions will be wrong decisions. The more trained, the more experienced we are, so will the proportion of 'right' decisions we make increase. But you can bet your life you'll never get one hundred percent.

That's not to be defeatist about it; just realistic about the fact that we are all human. Perhaps that's why the experts say that our safety record has bottomed out. There is surely a recognition there that wrong decisions are going to continue to be made.

One possible conclusion to reach is that we may be able to enhance our decision making ability if we each set ourselves some personal benchmarks in our flying — benchmarks which we have a commitment to adhere to when making decisions about our flying.

I've thought of a small example set of personal benchmarks which we might try applying to ourselves. They are just an example of what is possible — perhaps to get you started on a set more appropriate to your own particular needs. Working them out is not necessarily an easy task because there is always a tendency to try to be too comprehensive and in doing so defeat the purpose of the whole exercise. You see, for any set of benchmarks to be consistently applied they must be fundamentally simple. Otherwise we may fail to remember them or to make accurate decisions about them when we have reached them.

Anyway, here is an example set which you may like to consider. Keeping simplicity in mind, it is based on the mnemonic 'SAFETY' where **'S'** stands for Signs, **'A'** for altitude, **'F'** for Fuel, **'E'** for Evaluate, **'T'** for Turning, and **'Y'** for Yield.

Here's an explanation:

Signs — read the signs. If something doesn't feel or seem right, make a conscious decision to stop what you're doing and look at the signs. What are the clouds and cloud shadows doing? Where's the wind from and at what speed? Are there horses in the trees next to that short runway or signs of heavy rain the night before? What does the engine note tell you? The bulk of potentially hazardous situations in flying tend to pre-announce themselves. If you can read and react to the signs before things get out of hand: your chances of making more right decisions have to improve. Even if they're not pre-announced, most problems will be better solved if you remember to consciously stop what you're doing and read the signs.

Altitude — Set a minimum safe altitude for every flight of 1500 feet above terrains 10 miles either side of your track. There's space on the Flight Plan Form. If good VFR isn't possible at that altitude, look to turning back. This benchmark will keep you 1000 feet above terrain and 500 feet below the cloud base at all times.

Don't fly on top of even scattered clouds except where they're localised and well defined. Cloud shadows will help you make the right decision.

Fuel — always ensure a reserve of 60 minutes in your tanks on the runway at the end of your flight. If you can see during the flight that you're going to be short, look to alternative actions.

Evaluate — constantly before; during the progress of; and after your flight. What went wrong and what went right? How can I improve? Through constant evaluation, always know your position, your fuel state, wind direction, and the closest suitable landing area.

Turning — never sharp turns (more than 30 degrees of bank) below 500 feet. If you're below 500 feet chances are you'll be in a takeoff or landing configuration. Either way, airspeed will be critical and you'll have no time to recover if something goes wrong.

Yield — to the single minded determination to press on when the signs indicate that you are about to exceed one or more of your benchmarks.

Sound simple enough? Well, all this is not to say that the simple expediency of applying a set of personal benchmarks to our flying will improve our safety record overnight.

What they will do though is to provide you with a self imposed limit or reference point — a 'fence' if you like which will automatically ring alarm bells as you approach it. Because the time will surely come when you will ignore the limit. The point is that if your limits are set and are simple enough to easily remember, you will immediately know when you break them. This knowledge, in itself, can be very useful to you. You will know that you are entering into a possibly hazardous situation and steel yourself to a range of alternative actions. This is where the old adage of 'prior preparation prevents poor performance' comes into its own. Forewarned in the knowledge that you are breaking your own self imposed limits, there is a greater likelihood that you will be better prepared for the consequences.

So setting personal benchmarks on your own flying could, at the very least, stop you from getting into most potentially dangerous situations. But, in the event that it doesn't, there's at least a better than even chance that you'll be more adequately prepared for the consequences than would otherwise have been the case.

Perhaps the setting of these kinds of personal limits on your flying may appear a bit 'wimpish' to you. After all, one of the biggest advantages of private flying is the flexibility in personal transportation terms that it offers. To remain a useful tool it must also remain unrestricted by the imposition of arbitrary limits. But the line between what is practical and what is foolhardy must be drawn somewhere. That's why we have rules. Remember that red traffic light?

So give it a try. Use the suggested mnemonic as you write out your flight plan; as you're climbing to your cruise altitude; as an in-flight check list during any periods of inactivity; or when your sixth sense tells you all is not as it should be.

Perhaps setting some personal benchmarks in our flying could go some way towards improving our safety record ☐

Ice and water don't mix

by Roger F Tracey, Manager, Flight Operations, United Technologies International

THE COMPLICATED and varied interactions that determine the effects of water ingestion on turbine engine operation preclude detailed quantitative engine module by module analysis. The magnitude of the shifts in gas generator performance will vary depending upon the particular circumstances. However, the overall qualitative changes in engine operation resulting from the ingestion of water through the engine are listed below for a constant throttle position.

N1 & N2	May or may not be affected — Depends on engine control mode and amount of water ingested
EGT	Decreases
Fuel Flow	Increases
Surge	Increased possibility
Flameout	Increased possibility

Ingestion of water in liquid or solid form will affect engine operation because of the higher specific heat of water and the latent heat of vaporization associated with evaporation. When flying through heavy rain storms, the compressors of a dual compressor engine are 'rematched' by the water ingested. The reason for this is that when the water is vaporized within the engine, it absorbs about 1000 BTU per pound of water from the air passing through the engine, effectively reducing the air temperature in the downstream stages of the compressor and in the combustion chamber. The ingestion of ice further increases the cooling in the compressors as it absorbs heat while melting into water and then more heat as it evaporates. The degree of rematch is, of course, proportional to the water/air ratio and the compressor design. The compressor rematch moves the high pressure compressor operating line toward the surge line, as illustrated in Figure 1, thus causing the compressor to be more susceptible to surge.

In addition, the compressor and engine response may be affected by the water as the aerodynamics, tip clearance and sensed control parameters become modified. If sufficient water is ingested, compressor surge or engine flameout may occur.

The engine inlet size basically determines the capture area for water ingestion. However, the amount of air ingested depends upon aircraft and engine speed. At high aircraft speeds and low engine RPM more air is being forced into the inlet than the engine requires. Thus air is spilled out of the inlet which effectively reduces the size of the column of air being ingested. The water droplets, being heavy, are not ejected and the result is an increased water/air ratio. On a typical high bypass ratio engine, this 'scoop factor' during idle descent increases the water/air ratio by as much as 200 percent. Increasing engine RPM increases the airflow requirement while maintaining the same area for water ingestion. Reducing aircraft speed will also reduce air spillage around the inlet. This combination significantly reduces the water/air ratio as illustrated in Figure 2.

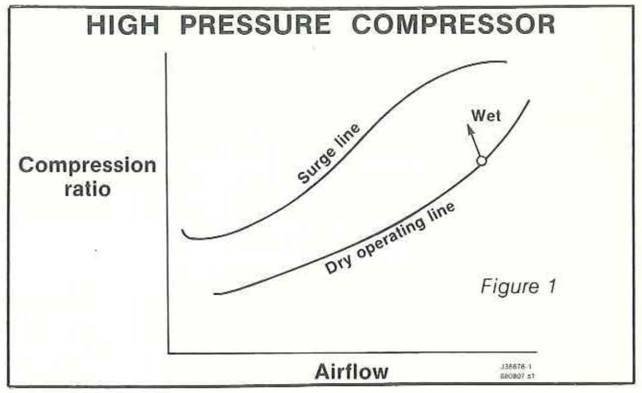


Figure 1

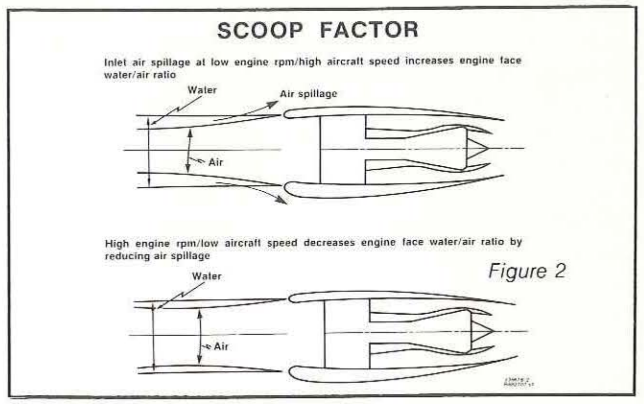


Figure 2

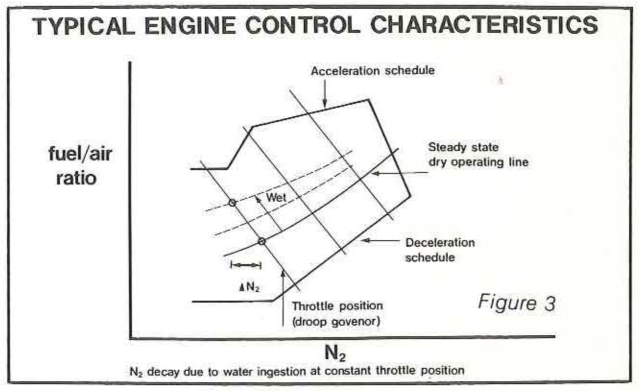


Figure 3

The effect of water ingestion on the engine response varies depending on the type of fuel control installed on the engine. Earlier model engines such as the JT8D and JT9D use a control with a droop governing mode, whereas more recent engines such as the PW2000 and PW4000 feature an isochronous governing control. The engine response characteristics pertinent to each fuel control are discussed separately below.

Figure 3 illustrates the effect of water ingest on on the fuel control schedules for engines which use droop governing controls. The dashed lines represent fuel required (operating) lines for various rates of water ingestion. As the water/air ratio is increased the operating line moves upwards toward the acceleration schedule. The higher the operating line the more fuel is required to run steady-state. It is apparent from the slope of the lines of constant throttle position on the diagram that a rise in the operating line results in a loss in N2 speed when throttle position remains fixed. The acceleration schedule represents the maximum fuel/air ratio available to the engine. As the operating line rises it can, under the most severe situation, reach the acceleration schedule, at which point the fuel control would be unable to deliver additional fuel to accommodate the increasing water ingestion. Under this condition, the engine would spool down to the point where the maximum fuel flow available was sufficient to operate the engine steady state. This would eventually result in spool down below idle, loss of the throttle response and loss of aircraft electrical power if the generator drops off the line. As the aircraft leaves the area of heavy precipitation, the water/air ratio would decrease and the fuel required line would lower, allowing the engine to re-accelerate to the original set speed providing surge or flameout has not occurred as a result of the water ingestion.

For engine controls which use isochronous governing, the engine response will be similar except that the rotor speeds will not change at constant throttle position as water ingestion is increased until the limiting acceleration fuel schedule is reached. At that point the engine would rapidly spool down.

The engine response to throttle movement varies depending on the direction the throttle is moved.

Throttle Advance

As the fuel control operating line rises due to the increasing water ingestion, the margin between the operating line and the acceleration schedule is reduced. The engine will respond sluggishly to an acceleration command from the throttle because of the reduced 'overfueling' capability of the control.

Throttle Retard

As the operating line rises, the margin between the operating line and the deceleration schedule is increased and the engine response to a throttle position decrease is more rapid than normal. This could result in a sub-idle condition and possible engine flameout.

In summary, the ingestion of water by a turbine engine results in the following:

1. Reduced surge margin.
2. Possible engine spooldown to sub-idle.
3. Possible engine flameout.
4. Sluggish response to throttle advance and rapid response to throttle retard.

Severe storms should be avoided. Typically the highest water concentration exists between 15 000 and 20 000 feet altitude. If flight must be made in extreme precipitation, the following techniques are recommended:

1. Turn on ignition system to protect against engine flameout.
2. Turn autothrottles off to avoid rapid throttle movements and protect against engine spooldown.
3. Reduce aircraft speed and increase engine rpm to reduce water/air ratio, increase engine energy to deal with water evaporation and protect against spooldown. This condition is most prevalent when at low thrust during descent and holding operation.
4. Avoid rapid throttle movements to reduce possibility of engine surge. If thrust changes are necessary move throttles very slowly and do not change throttle direction until the engine has stabilized.

These procedures are most effective if initiated prior to extreme precipitation.

An Aerospace Industries Association (AIA) committee consisting of representatives from engine and aircraft manufacturers are studying the effects of water ingestion on turbine engine operation. This article contains information available at this time. The results of the study and model specific recommendations will be forwarded as they become known.

This has been coordinated with the Boeing Aircraft Company, Douglas Aircraft Company and Airbus Industrie □

Mea culpa — a sobering confession

I HOLD a private licence with a command instrument rating and twin endorsement. I have about 500 hours in total of which 300 hours are Twin Comanche time and I am the proud owner of a Piper Twin Comanche PA30 Aircraft which is kept in good order and condition and which I fly regularly. The aircraft is equipped with DME, 2 VORs, 2 ADFs as well as HF Radio. I've held my private licence since 1982 and have passed two renewals of my instrument rating.

I planned a flight in the Twin Comanche from Coffs Harbour to Echuca to join in with the International Comanche Society Australian Tribe's 'fly in'. The flight was planned IFR, departing Coffs Harbour at approximately 0330 GMT, refueling Bankstown and continuing to Echuca, expecting to arrive after last light.

The weather for the trip was forecast to be reasonable with the possibility of thunderstorms to the west of Echuca at about my ETA. Having regard to the forecast and the fact that ETA would be after last light, I planned to refuel at Bankstown and thus have a maximum endurance of 280 minutes for the estimated 139 minute flight from Bankstown to Echuca.

My company on the flight was a friend who holds a Restricted Pilot's Licence and is currently training for an Unrestricted Licence.

The departure from Coffs Harbour was made as planned and the flight to Bankstown uneventful apart from some minor weather. Full refueling was carried out at Bankstown and departure timed at 0612 GMT. The planned time interval to Echuca ex Bankstown was 139 minutes. The endurance was 280 minutes leaving a planned margin of 45 minutes after allowance for fixed reserve of 45 minutes, IFR reserves of 20 minutes allowance (being 15% fuel for the flight time of 139 minutes) and provision of an alternate.

The flight proceeded smoothly and the weather near perfect.

The final leg from Corowa to Echuca was a distance of about 78 miles and would be flown VFR procedures as there was no aid at Echuca. The flight plan was to track outbound from the NDB at Corowa with a cross check at Numurkah, a town approximately 46 nautical miles on the direct track to Echuca. We arrived overhead Corowa at 0800 confirmed by the two ADF's (tuned to the Corowa NDB) falling away as anticipated. The outbound track was commenced on the 230 radial from Corowa with a heading of 235 degrees, a 5 degree drift allowance being made. The VOR and DME were both switched off as it was considered they would be of no further use. The No. 2 ADF was tuned to the off-track Shepparton NDB to enable directional orientation.

Darkness fell at Corowa and an estimate overhead Numurkah was made for the planned 0828 and care was given to track outbound from the Corowa NDB on the planned track. Approaching 0820 a lit town was sighted over the nose of the aircraft and at 0827 both pilots identified to their satisfaction that town as Numurkah. The No. 2 ADF was reviewed and showed a station at 330 relative. The WAC chart was also reviewed and the major road noted running through the town identified as the Valley Highway running north-south as well as a minor road running away from Numurkah to the west, the roads being clearly visible. At this point, being happy with the navigation, the flight continued and a ground speed check was undertaken that showed an average ground speed since Corowa of 146 knots which is within expectations for the aircraft.

At about 0840 the lights of a large town appeared over the nose of the aircraft and we considered that Echuca was in sight. Our ETA for Echuca was 0840 and the ETA was accordingly amended to 0847 and Flight Service advised.

Communication at this stage was commenced with an inbound aircraft to Echuca. Communication was poor and the first inklings of trouble with navigation became apparent as we were unable to sight either the inbound aircraft or the Echuca runway lights. It quickly became obvious that the town which we had identified as Echuca was not our intended destination.

Flight Service was immediately advised of the difficulty and were most helpful and supportive in our predicament. Flight Service immediately sought my endurance, POB, our last reported position, heading since then and TAS, of which were provided as promptly as workload would permit.

They suggested the PAL for Shepparton be activated. Unfortunately this proved ineffective and a command decision was made to return to Shepparton. The NDB for Shepparton was tuned in on both ADF's and the aircraft took up a heading of 060 with both ADF's on the nose and Flight Service was advised of our intention.

At this stage, severe directional disorientation was experienced and while no difficulty occurred in the mechanics of flying the aircraft the directional disorientation was most disconcerting. I had no knowledge as to how far Shepparton was from my known position and this created significant stress and pilot workload.

Flight Service then, and without any pressure, requested that I tune up the Mangalore navigation aids, advising the DME number which I tuned and was successful in receiving. The VOR frequency was next but wouldn't tune up. In trouble shooting this problem I remembered that I had turned off the VOR! The VOR was immediately turned on and activated. Thereafter the OBS was turned until the flag read 'To' and the CDI centered. The track to Mangalore was read off the instrument and the aircraft's heading was brought around to track to that station.

Flight Service had arranged for the lighting at Mangalore be switched on and the rotating beacon activated. What a welcome sight! We were given the forecast for Mangalore NOTAMs were advised and an offer to activate the cross-runway lights if we preferred that direction. In the circuit area as we entered the landing pattern Flight Service's advice to 'check wheels' was welcomed and appreciated! We landed safely at Mangalore and SAR was canceled on HF.

Needless to say, we were grateful to be on the ground and somewhat disconcerted that despite careful planning for the Corowa — Echuca leg we had been unsuccessful in reaching our planned destination.

It didn't take long when reviewing the charts and flight plan to find that the correct track from Corowa to Echuca was indeed 250 and that for some reason this had been transposed on the flight plan to 230. A careless error which could have had serious consequences.

Normally when preparing a plan for such a VFR leg I take the track direct off the IFR en-route chart with the use of a protractor and I am unable to explain how the error in the track occurred in the preparation of this flight plan.

The cross checks that I had instituted also failed to indicate early enough the impending difficulties and only goes to illustrate how one small careless error can lead to an accumulation of problems.

In hindsight there are many lessons to be learnt and I list some of these for your consideration:

1. Endurance — it is true that endurance is one of the more important aspects of flying — particularly under IFR, when the destination does not have an appropriate aid, ETA is after dark and the weather forecast is marginal.

   Whilst the pressure placed upon me due to my error was considerable it was not half as considerable as it may have been if either fuel was a minimum or the weather had been bad.

2. Normal careful flight practices tend to fall away when pressure is applied and it is important to realise that those long established practices and training which we all undergo as pilots must be put into effect when difficulty is encountered.

   Stress creates a lessening of flying ability and a conscious effort had to be made by me to overcome rising panic, to put in place those good flying practices in which I had been trained and get down to the task of resolving the difficulty in which I found myself.

3. It is hard to imagine the directional disorientation that one can suffer in the situation described, even when Instrument Rated, as the brain refuses to accept the obvious that you are not at the location at which you should be.

4. It is also difficult to depart to another location of safety when the location of the departure point is unknown, and therefore the distance to the 'safety point' is unknown. This only served to create further stress.

5. I managed to overcome these problems reasonably successfully, setting up the aircraft for maximum endurance, ensuring that it was flown carefully at an appropriate altitude and endeavoring to resolve logically the dilemma by tuning in the appropriate heading and tracking to the aids.

6. Hindsight states the obvious that better use could have been made of the off-track aids at Shepparton and Mangalore. I had at my disposal aids which included NDB, VOR, DME which if used appropriately could have prevented significant stress, anxiety, and embarrassment!

7. Flight Service — The value of assistance and support from the Melbourne Flight Service Unit was inestimatable. Their prompt and professional assistance was a most valuable weapon against the rising panic accompanying our navigational uncertainty.

This incident serves to show how one small act of carelessness can lead to a chain of events which may have an unhappy conclusion. That chain of events however can be broken if the disciplines learned during the hours of training are skillfully applied, all appropriate resources available are utilised, adequate fuel is available and the pilot is able to draw from his training and currency in piloting techniques.

Any fool can make a mistake but successful recovery requires more than being an ordinary fool! □

TRAPS FOR YOUNG PLAYERS

Trap 1

During a flying training sortie the instructor simulated an engine failure by moving the mixture control to the idle/cut-off position. The student closed the throttle and pulled the carby heat on. The instructor then moved the mixture control to rich.

During the subsequent descent the throttle was opened twice. Each time the rpm was brought up almost to the green arc for about three seconds.

Because they were in a low flying area the instructor allowed the descent to continue to about 100 feet agl where he requested a go-around.

The student moved the carby heat to cold and applied full throttle. The engine responded normally.

When the aircraft was climbing through 200 feet agl the instructor simulated an engine failure after takeoff by again bringing the mixture control to idle/cut-off.

The instructor's main concern was to see that the student quickly lowered the nose to maintain flying speed. When the nose was lowered he reselected the mixture to rich. The throttle was still fully open.

There was no response from the engine. The instructor took control and manipulated the throttle without success. The aircraft was landed in swampy scrub with considerable damage. The occupants were unhurt.

The dry bulb temperature at the time was 20 degrees and the dew point 17.

Trap 2

During the pull up at the end of a clean-up run, a small note pad fell to the floor of the cockpit. The pilot leant forward to retrieve it but almost immediately the aircraft struck the ground.

The note pad was used to record spraying details that were not critical to the operation of the aircraft.

Trap 3

The aircraft was engaged on a multi-sector flight for the purpose of transporting bank documents. The pilot completed the pre-landing checks and made a normal touchdown on runway 05.

During the landing roll the undercarriage began to retract and the left main and nose gear subsequently collapsed.

It was believed that the pilot inadvertently selected the gear up instead of the flaps.

Trap 4

The departure from the ALA at Shute Harbour had been delayed and the pilot was running late for arrival at Hayman Island — an arrival that was to be filmed by a TV crew that was already in position.

During the short flight the pilot noticed that the airspeed was slightly lower than normal but he attributed this to the possibility of water in the pitot system — a problem that he had encountered the previous day in another aircraft and that he had discussed with other pilots that night. He tried pitot heat to correct the problem without success.

The aircraft was to land on the water. The pilot noticed on short final that the flap was not in the landing position — which he then selected. On touchdown, the pilot realised that the wheels were still extended.

He tried to prevent the floats digging-in but the left wing struck the water before the aircraft came to rest.

Sea survival

by M J Sonneveld (John)

THE FOLLOWING is a brief story concerning survival in the sea.

After last light on 22 January, 1979, I was informed of a missing yachtman in Westernport Bay, Victoria. At the time I was employed to fly a Surf Rescue Helicopter. The information I was given was that the man had been sailing a very small (Pram) yacht and had not returned to Phillip Island as expected.

As is common in reports of a person missing in Westernport or Port Phillip Bay, the seriousness of the situation is not obvious until quite late in the day after all other reasons for the persons absence have been exhausted by family and or friends.

The formal search was not commenced until about 30 minutes before last light. All inexpensive means of searching were availed of first; the helicopter was not called out: nor could it have achieved a great deal at night. Rescue Helicopters were not quite as sophisticated in those days. The night was quite warm and the seas were calm. However, the sea currents in Westernport reach about six knots and the man could have drifted a long way in a relatively short time.

The man was not found that night. By next morning the authorities were concerned enough to pay for more expensive resources. So the rescue helicopter was called out at first light. The swamped, missing yacht was found by the helicopter crew about 90 minutes later. Some hundreds of metres from the swamped yacht we saw the very pale, exposed head of a man still wearing his yellow life vest; he was dead from hypothermia. He had been in the water for about 13 hours.

With this story in mind, how on earth will people survive who have been forced to ditch their aircraft in an expanse of sea such as Bass Strait? I believe that most of the responsibility falls on the pilots to ensure that they and their passengers have a chance.

Assume you are island hopping across Bass Strait in a single engine Cessna with two passengers. Midway between the Kent Group and Flinders Island you have an engine failure. You manage to get out a Mayday; you prevent the aircraft from breaking when it contacts the water by 'holding off' close to the water as long as possible. Were you wise in requiring all on board to wear their life vests or did you leave the life vests in their valises to avoid soiling them? Lets say you were lucky and all on board managed to be wearing their life vests before the Cessna sank. (You might be very lucky to have the aircraft afloat for three minutes.) Now the three of you are in the sea. Where is your survival beacon. Oh! It was mounted in the aft fuselage; it has disappeared with the aircraft. Sure a search will be mounted as soon as possible but finding you will be about as difficult as finding three needles in a hay-stack. You are as good as dead.

Assume you were wiser. On the same flight you all wore your life vests and you managed to borrow a four man life raft. You all got into the raft and though cold and wet none of you was injured. However, the survival beacon sank with the aircraft. Have you any comprehension how difficult it is to see a small life raft bobbing in the white caps in a large expanse of sea. You may be lost for days or perhaps it is sunny and you knew how to use the helicopter to flash one of the search aircraft. Later you are rescued by a helicopter. You will most certainly be sea sick and quite possibly suffering from a degree of hypothermia. You are very thankful for the rescue but are you wiser?

Assume you are well prepared for the above ditching. You are all wearing your life vests. The life raft is large enough and readily accessible in the aircraft. You are also equipped with as survival beacon designed to operate in the sea. You had briefed the passengers properly on what to do in the event of ditching and they remembered the instructions. You find yourself in your life vests, in the raft with the beacon on. Ninety minutes later a large helicopter is winching you out of the sea. This helicopter is equipped with a very efficient Automatic Direction Finder which enables the helicopter to locate your beacon quickly.

But what of the man who went missing in Westernport and was found dead. The helicopter crew who just rescued you would have a simple answer to that. They will each show you the small, inexpensive strobe light which they wear attached to their body or equipment. A small strobe light can be seen for many miles at night □

AIRFLOW

Dear Sir,

Survival Gear carried

Let's get more wisdom into survival preparation.

Could we have:

1. Learned statements from 'The Authority', other authorities and experts on precisely what these items mean to them.
2. Comment from one and all about how they understand requirements for first aid, emergency rations and water.
3. Suggestions as to whether more or less items should be included on the flight plan from under 'survival gear carried' (fire lighters, 'space blankets'?).
4. Suggestions as to what should be carried in practice in the aircraft under these item headings.
5. Accounts of real situations in which such items or others have proved useful, useless or a hindrance.

To start the non acrimonious process let me say that most FIRST AID kits I have seen are a joke, a financial rip off, and are often treated as such — certainly rarely relating to needs of survival.

For example, tiny whisps of cotton wool, little bandages, bottles of antiseptic and other 'toys' are unlikely to benefit by comparison with say reversible adult/child artificial airway, robust bandages, pads and adhesive butterfly 'sectures' to maintain respiration and arrest bleeding.

What sorts of rations for how many people for how long?

What weight/load ratio, cost/length of preservation ratio? Necessary? Minimal? Mandatory? Desirable? Excessive/undesirable?

Recent reminders in the *Aviation Safety Digest* of need for rehydration in the air and on the ground (half a litre per half hour and so on) make a mockery of a two litre plastic bottle of water (which may be remembered, and could be full 'if you're lucky'/sensible) to be shared between 2-4 persons during air work or private flight — doubling up as meeting the additional need for water in an emergency. Should all instructors/pilots have basic first aid/survival training? Examinable as part of licensing? Available free on a voluntary basis at all training establishments? Would such training do more harm than good? If so, would we also be better off flying without training?

Donald Scott-Orr

Dear Sir,

I am presently a private pilot with 140 hours and am now looking forward to obtaining my commercial licence in the next few weeks. I have only been flying for a very short time (1 1/2 years) and so the training I received for my licence is still fresh in my mind.

Of course one thing I noticed is that a lot of this training was concentrated on perfecting my forced landings.

It was very reassuring to know that my instructor could cut the power at almost any time and that I would usually find a suitable place to put it down.

So now you would think I am fairly confident that if the real thing happened, I would be able to run through my emergency checks and if the problem could not be rectified, find a suitable clearing and bring it down for a safe landing — but I'm not. In fact, I'm rather worried because now I realise something crucial to a successful forced landing had been omitted: THE LANDING ITSELF!

During all that time spent going through the emergency checks, finding the next suitable area to land, and making the correct Mayday calls, not once did we ever get below 300 ft.

Surely what happens in the last 300 ft is what determines whether you and your passengers survive or not, and if you have never been shown what to do in these final seconds, the rest of the training before it is rather useless.

I must imagine there are different techniques for putting aircraft down on different surfaces, for example:

- How would you touch down on a flat paddock as opposed to one on a hillside?
- How should you put an aircraft down in an area of tall trees? Should you stall it just above the tree tops?
- How do you ditch an aircraft in water to prevent it flipping over?
- Do techniques change for fixed and retractable undercarriages?

I have asked a number of people these kinds of questions but none have really given me a satisfactory answer. Maybe they have the same problem I have or maybe they have never really thought about it.

I would really appreciate it if you could produce an article in a future digest about this important area of air safety.

Yours sincerely,

Michael Badge

Relevant articles are planned for the Winter ASD 1989.

AIRFLOW

Dear Sir,

With reference to ASD 137 the section on permissible defects; that although the throttle accelerator pump can be used for starting, it is quite likely to cause a fire due to misuse and so what you have written may be dangerously misinterpreted.

The primer supplies a metered quantity of fuel into the cylinder. The accelerator pump relies on intake suction to draw the fuel not the cylinder.

By pumping the throttle and activating the accelerator pump you can not meter the quantity of fuel. This fuel is sloshing around the bottom of the engine from the intake manifold and is downstream from the carburettor and can lead to fire, during the start because of backfiring.

If the primer is unserviceable, fix it. If it is urgent to fly the aircraft, activate the accelerator pump only when cranking the engine to minimize fuel accumulation.

Yours faithfully,

Elly Brooks

I fully endorse and totally agree with the comments made by Elly Brooks.

I would only add that if you MUST use the accelerator pump, be aware of the potential for an induction fire and if one eventuates or is suspected, continue to crank the engine. This has the effect of 'swallowing' the fire. A further caution is warranted however. A starter jam is also a potential result of a backfire and should this occur the situation is exacerbated with the obvious result. Following such an incident a close inspection of the induction system should be performed.

Bob Scott
Principal Engineer
Mechanical Systems
Civil Aviation Authority

Dear Sir,

In the current issue Winter '88 of Aviation Safety Digest a very misleading suggestion on Page 22 has been given in relation to compensating for the wind with two timed runs.

A distance travelled is not the average of two dissimilar time/distance estimates. Average speed equals total distance over total time.

Take the example of a 3600 foot strip and a 60 knot airspeed. Allowing for a 20 knot wind, the ground speed one way equals 80 knots, ground speed the other way equals 40 knots. The time to travel 3600 feet at 80 knots equals 26.7 seconds, the time to travel 3600 feet at 40 knots is 53.4 seconds, giving a total time of just over 80 seconds. If you assume your average speed was 60 knots i.e. approximately 100 feet per second, you would come up with a strip length of 4,000 feet, an error of over 10 percent.

It could be seen that taken to the limit, if the wind was 60 knots, the downwind ground speed will be 120 knots, time to travel one way 18 seconds, but you would never get back again as your ground speed would be NIL. In other words, to average 60 knots would be impossible in a 60 knot wind. The higher the wind velocity, the greater the error.

Since many errors less than 10 percent have added up to accidents in the past, I don't think this is a very good method of estimating strip length.

Yours faithfully,

P J McNiven

Quite correct, but the contributor was only suggesting a method to 'estimate' distance more accurately than 'eyeballing' the strip. As you have, both he and the comment provided by David Robson cautioned against the margin for error which will be influenced by significant airspeed and windspeed differences. As long as one is aware of the margins for error and makes sufficient allowance, it is far better than not making a calculation at all!