# GLIDING FEDERATION OF AUSTRALIA

# BASIC GLIDING KNOWLEDGE

**FIFTH EDITION**

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FIFTH EDITION, 2001

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# INTRODUCTION

Although the title of this book is largely self-explanatory, a few words of further explanation may help to understand its specific purpose.

The Gliding Federation of Australia (GFA) is responsible to the Civil Aviation Safety Authority (CASA) for the conduct of safe gliding operations in Australia. This includes the setting and maintenance of flying standards and in particular training standards.

Glider pilots are exempt from holding pilots licences. GFA is responsible for the establishment of pilot certificates which are regarded highly enough for CASA and the aviation industry to be considered as a satisfactory substitute for licences.

As the basic building blocks of learning to fly gliders, the GFA has established three levels of pilot certificates, known simply as the A, B and C Certificates. The purpose of these three levels is to progressively build up pilot ability and confidence, offering the developing pilot more privileges as experience increases. They may be considered as the basic certificates of competence and therefore as the loose equivalent of the various stages of licences that power pilots hold.

The ultimate training objective of the GFA is to produce safe and efficient cross-country pilots. On the basis that walking comes before running, it is necessary to put in place a certain level of knowledge and some unbreakable habits of safety before raising the sights to the goals of the various international badges of achievement or to become an efficient competitive glider pilot. The A, B and C Certificates help to cement the knowledge and safe habits into place.

Not all pilots want to fly cross-country all the time, nor do they necessarily want to compete. Some pilots enjoy sharing a two-seater for a pleasant couple of hours soaring or introducing other members of their family to the pleasures of our sport. These certificates are also aimed at helping them to achieve these ends.

Most glider-pilot training is practical and “hands-on” in nature. However, there is an amount of theoretical knowledge which is not only desirable, but actually makes the task of learning to fly easier and more pleasurable. The theoretical knowledge is imparted progressively as flying training continues.

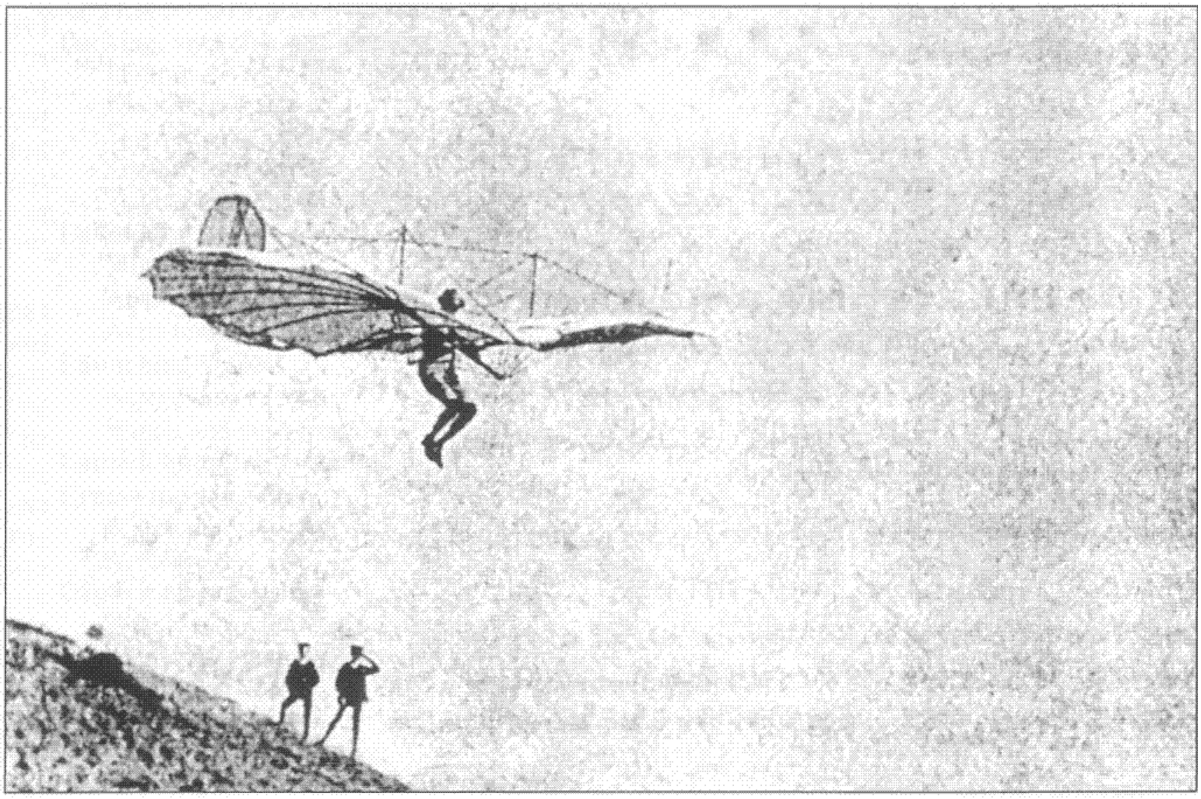
The purpose of this book is to provide a reference for the kind of knowledge which you will need as you progress through the various certificates. It covers everything you will need during training, from the basic reasons why a glider is able to fly in the first place to the meteorology which enables it to soar. It also covers most essential items in between, such as air legislation, basic navigation and use of radio.

Integrated into the three basic pilot certificates are oral examinations on all aspects of the basic theory necessary to become a safe glider pilot and take your place in the air with other formally trained pilots. All the material on which these oral exams are based will be found in this book.

# CHAPTER 1 - WHAT IS GLIDING?

## BACKGROUND

Gliding as a form of sport aviation had its beginnings in the 19th century, when Sir George Cayley built and flew a successful glider. He was followed by such pioneers as Otto Lilienthal and Percy Pilcher, both of whom flew gliders bearing a remarkable resemblance to the modern hang-glider, although constructed out of much more primitive materials. At that time people were concerned with emulating the birds as far as possible and many gliders tended to be bird-like in appearance, except of course that they did not flap, at least not intentionally.



*One of Otto Lilienthal's glider designs*

Having managed to get their machines into the air, which was usually by jumping off a hill, the next problem was to stay there for more than the few seconds the pilots had managed to achieve so far. This new objective, known to us now as **soaring,** was a logical extension of mere gliding and came about because of the pilots' insatiable quest for various kinds of rising air in the atmosphere in order to prolong their flights.

### Hill soaring

Even after gliders had graduated from the Lilienthal and Pilcher style of machines into something more nearly resembling a modern glider, pilots tended to confine themselves to hills and slopes, partly because they needed the hill to launch themselves and partly because they had discovered a reliable form of "lift" produced by the wind blowing up the windward face of the hill. Durations of many hours could be achieved in this way - as long as the wind blows in the right direction at the right strength, the lift can be used. The World duration record of over 50 hours was gained by slope-soaring in this fashion, until such records were banned by International agreement because of the number of pilots falling asleep and killing themselves.

*Contrast Lilienthal's primitive machine with the sleek lines of this beautiful "Janus" two-seater, waiting for its crew at Wigram, New Zealand.*

### Thermal soaring

It was the discovery of "thermals" in the 1930s that freed glider pilots from the hills and enabled them to set out on cross-country flights following the energy spawned by the sun. It was realised that the sun heats up differently-coloured land areas at different rates and this creates bubbles of rising warm air, called thermals, which can be used by gliders to stay aloft. The bubbles are of relatively small size and it is necessary to circle the glider to stay inside the bubble and to gain height. This technique of "thermalling" took a while to catch on, but it was eventually realised that here was the answer to cross-country flying independent of the hills and indeed of the wind. And so it has remained to this day. Thermal soaring is still the most common method of soaring for glider pilots all around the world and cross-country flights of over 1000km are becoming commonplace in Australia and elsewhere. Thermalling is a skill that no glider pilot can afford to be without.

### Wave soaring

Not long after thermals were discovered, a few pilots in Europe and Britain stumbled upon a new and mysterious form of lift. It was experienced in the vicinity of hilly and mountainous terrain, and produced areas of strong and unbelievably smooth lift to great heights. Interspersed with the areas of uncanny smoothness were narrow bands of ferocious turbulence, some of which was strong enough to cause gliders to break up in flight. Such conditions frequently brought with them strange lens-shaped clouds, like eyebrows, in the sky.

Exploration of these conditions led to the discovery that they were caused by a "wave" action of the air blowing over a range of mountains situated across the wind. The action is similar to that seen in a river, where the water flows over a large rock on the river bed.

The wave action set up by the rock transmits itself right up through the layers of water to the surface, and the wave remains stationary with respect to the river bank, the water flowing through it. The wave also continues downstream of the rock, maintaining exactly the same wavelength but diminishing in amplitude until it peters out.

Exactly the same happens in the atmosphere and this is what these pilots were experiencing. Today, wave phenomena are quite well understood and the World height record of over 48,000ft was gained in wave lift over the Sierra Nevada mountains in California. In New Zealand, distance flights of over 2,000 kms are being flown, using mountain waves to provide the source of lift to keep the gliders airborne for anything up to the 16 hours or so necessary to complete such a flight.

From all this, it can be seen that gliding is a pure recreational and sporting activity. It is of no use as a means of transport; you cannot use a glider to reliably get from A to B. To fly gliders, you need to want to fly for its own sake and you need to be fascinated by the idea of staying in the air and flying cross-country by a combination of the use of natural weather phenomena and your own skill.

Gliding clubs are cooperatives of people who have exactly these objectives in mind.

*The club "cooperative" at work at Bachelor in the Northern Territory. Qualified club members carry out the Daily Inspection of the Blanik two-seat trainer in the foreground, while in the background the winch is prepared for the day's operations.*

## HOW DO GLIDERS GET INTO THE AIR?

We have seen that there are several ways in which a glider can stay in the air for long periods of time. But how does it get up there in the first place without a power source?

There are several methods of launching a glider into the air to enable it to go hunting for lift. Jumping off hills is no longer feasible for modern glider designs, with the notable exception of hang-gliders, which still use this launch method with considerable success. Even the once-popular bungy, or catapult, method of launching gliders is no longer in common use.

Common methods of launching gliders are by aerotow (towing with a light aircraft), by winch or by motor-car (known as auto-tow). In addition to these methods, gliders can be fitted with a small engine to self-launch.

### Aerotowing

Aerotowing is used by about half the gliding clubs in Australia. The glider is attached to the tug aircraft by about 55 metres of polypropylene rope and the combination simply climbs in formation to a suitable height for the glider to release and find lift. The rope can be released from either end if the need arises. Advantages of aerotowing are reliability (tug engines seldom fail and ropes seldom break), the ability to cover a large area of sky in the search for lift, and the small number of ground crew needed to commence operations. Disadvantages are high cost (tugs are maintenance-intensive and fuel costs are high), relative inefficiency (each tow takes a long time) and the necessity for licensed pilots to be present to operate the tugs. The increasing costs of aerotowing may result in less clubs choosing to launch their gliders by this method in the future.

*A tug and glider combination, using the standard Australian "low-tow" position, with the glider below the tug's slipstream*

### Winch-launching

A winch is a static device, consisting of a powerful engine driving a large steel drum on which is wound about 1500 metres of wire. The whole mechanism is mounted on a chassis which can be driven to a suitable position on the airfield. The gliders are launched by being attached to the end of the 1500 metres of wire, appropriate signals then being given by bat or radio to the winch-driver by the crew at the glider launch point. In the full climb the gliders climb steeply, at about 45 degrees nose-up, and reach a typical height of 1500ft in under a minute. After the glider has released, the wire is wound in to the winch, whereupon it is attached to a car or tractor to be taken down the field to launch another glider. In some cases (the so-called "self-laying" winch design), the winch itself is mobile and is driven back to the launch point to once more lay out its cables. The wire most commonly in use to winch-launch gliders is 2.8mm spring steel wire, the wire used to make bed-springs.

As a rough guide, the height gained on a winch-launch in a light wind will be about one-third of the length of the cable at the start.

Advantages of winch-launching are - reasonable cost per launch; a glider can be launched on about a litre of fuel, it is easier to train winch-drivers than it is to train tug-pilots, it gives a reasonable launch-height very quickly in comparison with aerotowing, and winches are much cheaper to build and maintain than tug aircraft. Disadvantages - winches are fairly complicated and reliability is not as good as with aerotowing, although this disadvantage can be overcome by good design and careful maintenance; wire breaks more frequently than aerotow ropes do, and calm conditions have a detrimental effect on launch height.

*A typical gliding club winch*

## Auto-towing

Alternatively known as car-launching, this method simply involves towing the glider on about 500 metres of wire behind a powerful car or ute. The glider climbs in the same way as for winch-launching and after release the wire is towed back for another launch. It is generally simpler than winch-launching, but a long smooth runway is necessary for successful auto-towing, a figure of 1600 metres being the absolute minimum and much more being preferable. One additional advantage of auto-towing is that materials other than wire can be used for launching the gliders, polypropylene yachting rope and Parafil (parallel filaments of terylene) being two examples in use in Australia. This is a great advantage if there are power-lines in the vicinity of the aerodrome. The spectacle of a steel wire being accidentally draped across a 500,000 volt line is better imagined than experienced.

## Powered sailplanes

It is possible to fit a small engine to a glider in order to make it self-launching, thus freeing it from the queues which are such a feature of busy launch-points on a summer day. The engine may be a fixed installation in the nose, powered-aircraft style, or a retractable device fitted on a folding pylon behind the cockpit. A wide range of engines may be used, from two strokes of 15 to 20 kw to Volkswagen engines of more than 60 kw. The moderate wing loading and low drag of a modern glider make it possible to self-launch on such low power. Small jet engines are also being tested in self-launchers and electric power offers a new alternative for the future.


*A Brasov IS28M2 powered sailplane, with a VW-derived engine*

## COMPETITIONS

Gliding is a sport and has a very strong competitive element. Modern gliding concentrates on racing around closed-circuit tasks as a test of efficient soaring skills. There is a National Championship every year and annual State Championships too. In addition to these major competitions in the peak soaring season (October to March), there are many smaller regattas and suchlike events, which enable pilots to sharpen their racing skills without the pressure of serious competition.

For the purpose of competitions, gliders are split into several classes by international agreement, and pilots can choose which class they wish to fly in before purchasing a sailplane to suit, or using one from their club. The various classes are as follows -

### Open Class

Anything goes in open class - unlimited wingspan, unlimited gadgetry, and unlimited cost. The Open class is where much innovative glider development takes place, and is the gliding equivalent to Formula 1 motor racing. Developments such as wing flaps, retractable undercarriages and water ballast first appeared in the open class years ago, and these things are now fairly commonplace on club single-seaters.

### 15 metre class

Almost as unlimited as the Open class, but with wingspan restricted to 15 metres. Also referred to as Racing Class.

### Standard Class

The same 15 metre wingspan restriction as for Racing Class. However, flaps are not permitted in Standard Class. In spite of this restriction on flaps, some modern Standard Class gliders have an overall performance as good as gliders in the 15 metre class.

### Sports Class

This class is somewhat difficult to define, but could be said to include all those gliders which would not be competitive in any of the other classes. Generally speaking, the older gliders fly in Sports

Class, and many of these machines are of wooden construction. Sports Class is enjoying an increasing following in Australia, largely because of rising costs in other classes.

### Two-seater Class

This is self-explanatory and two-seaters usually compete in a separate sub-category in Sports Class events.

### World Class

This is a category of single-seat glider designed specifically to keep costs down. There is only one World Class design, the Polish PW5 "Smyk". The glider may be built under licence in any country in the world and the design is fixed for a minimum of 15 years from the date of its first certification in 1994. A category of competition for the World Class exists in the Australian National Championships and in the World Championships.


*The prototype PW5 "Smyk" World Class glider*

## RECORDS

Glider pilots may attempt records at National and World level. Records exist for height, distance and speed over a closed-circuit course and must be homologated by the Federation Aeronautique Internationale (FAI). Australia is a natural venue for gliding records, and pilots come here from all round the world to sample our excellent soaring weather. Several World records are held by Australian pilots, and very large record-breaking triangular courses are regularly flown from such inland places as Narromine, Tocumwal and Waikerie.

## GOVERNMENT AND GLIDING

Under the Civil Aviation Act, 1988, the Government of the Commonwealth of Australia delegates responsibility for the regulation of civil aviation to the Civil Aviation Safety Authority (CASA). Standards are set in accordance with CASA's perception of an acceptable level of public safety and such standards are formally laid down in the Civil Aviation Regulations (CARs) or, in the future, Civil Aviation Safety Regulations (CASRs).

Gliders are Australian-registered civil aircraft and as such are required to comply with the CARs. However, there are some of the CARs which are clearly not applicable to motorless sporting vehicles, others where negotiation has taken place to waive the CAR requirements for a variety of reasons. This results in a number of exemptions being granted by CASA from compliance with certain of the CARs. These exemptions are contained in another CASA document called a Civil Aviation Order (CAO). The Gliding Federation of Australia (GFA) has two specific CAOs allocated to it for clear enunciation of all its exemptions and the conditions under which the exemptions are granted. The gliding “exemption” Orders are CAO 95.4, for most of our operations and CAO 95.4.1 for “charter” (hire and reward passenger-carrying) operations.

In conjunction with CAOs 95.4 and 95.4.1, the GFA also has a set of Operational Regulations (Op Regs), which set out basic standards for matters such as registration and markings of gliders, personnel standards, general conduct of operations and flight rules and procedures.

Neither CAOs 95.4 and 95.4.1 nor the Op Regs can be altered without the approval of CASA.

The net result of all this is that GFA exists as a “self-administrating” body, basically marching to the drum of the regulatory requirements but with some flexibility to make unilateral decisions and also with a significant number of exemptions from the CARs which are not enjoyed by other operators of civil aircraft.

It is important to realise that there are other users of the air in which we fly. These range from the airlines and military aircraft to commuters, light single and twin engined aircraft and of course other sporting aircraft such as ultralights, hang gliders, etc. Each pilot of those machines is required to know the basic rules to which all flying machines must adhere. It is only fair that glider pilots should be subject to the same discipline. CAOs 95.4, 95.4.1 and the Op Regs give other airspace users the confidence that CASA has approved the basic rules by which we operate.

From the point of view of day-to-day gliding operations, the CASA “stamp of approval” on our Operational Regulations is not intrusive. GFA standards are set and maintained by people who are first and foremost experienced glider pilots and instructors. The GFA consultative process is followed whenever changes to operational procedures or standards are contemplated. The supervisor of standards in each Region of Australia is a GFA person, not a CASA person. With all this in mind, there is one more important document which sets out the detailed rules and recommendations of the GFA for all to see.

This is the Manual of Standard Procedures (MOSP), which has been regarded as the prime working document for Australian gliding since the inception of the GFA in 1950. The MOSP still retains this stature, containing information which is of little interest to those outside gliding but which is vital to those directly involved in the sport.

All the above-mentioned documents are combined into one consolidated GFA Operations Manual, free copies of which are supplied to all clubs. Individuals may purchase copies of the Ops Manual from the GFA Secretariat.

To summarise, GFA exists primarily to administer the safety and proper conduct of gliding as an alternative to coming under comprehensive Commonwealth regulation. Rather than being an authoritative body policing gliding with some unworthy intention, the GFA should be seen as a buffer placed between outright Government control of the sport and the clubs and individuals engaged in gliding activities. The essential difference between direct Government control and the “self-administration” exercised by the Federation lies in the amount of representation that each person has in each case. It is important that people coming into gliding understand this situation and it is a necessary function of member clubs and organisations to explain it to them.

## Gliding operations in Australia

There are about 3000 glider pilots in Australia, operating more than 1,000 gliders from over 100 clubs. GFA trains all gliding instructors and airworthiness inspectors and no CASA pilot's licence is necessary to fly gliders in Australia, the GFA/FAI qualifications being accepted as the "equivalent level of competence".

To learn to fly a glider it is usual to join a gliding club, or undertake a course at a full-time operator. In this respect gliding differs from power flying, where it is usually possible to book an hour or so's instruction without being a member of the organisation itself. Gliding cannot work in the same way as powered flying, because so many people are necessary on the ground to enable one person to fly. This creates a team spirit in gliding which is almost entirely absent from powered flying. Some people of an impatient and selfish disposition are irritated by the amount of work they need to do in order to get into the air, but it is part and parcel of the sport of gliding and has stood the test of time very well. Glider pilots are not just pilots - they are skilled at many other jobs on the airfield too.

Most gliding clubs have a Student membership rate, available to all members who are under the age of 18 years or are full-time students. A Student membership rate also applies to the Gliding Federation of Australia (it is necessary to either be a GFA member or to undertake in writing to abide by GFA procedures in order to legally undertake glider-pilot training). Student membership rates offer considerable cost savings to young people. Costs go out of date very quickly, so there is no point in quoting typical ones here. It is sufficient to say that the cost of flying gliders is a lot less than flying powered aircraft.

The minimum age for flying gliders solo in Australia is 15 years. This is considerably younger than the minimum age for going solo in an Australian-registered power-plane, so by the time a person is old enough to legally solo a light aircraft he/she could have enjoyed quite a lot of time as pilot in command of a sailplane acquiring and developing the skills of soaring.

The Civil Aviation Safety Authority recognises a Silver C as being sufficient qualification for an "hours" concession to be granted when training for a powered licence. A Silver C glider pilot should not start a conversion to powered aircraft (whether ultralight or General Aviation) without first enquiring of the flying school about this concession. It can save a lot of money.

# CHAPTER 2 - THE TRAINING PROCESS

## PRE-SOLO TRAINING

Training is carried out in two-seat gliders, most trainers being of "tandem" layout, the student occupying the front seat, the instructor sitting behind. In these gliders, all essential controls and most of the instruments are duplicated for each occupant.


*The cockpits of the Polish KR-03A "Puchatek" tandem two-seat trainer*

A few gliders, and quite a number of powered sailplanes, are of side-by-side (e.g. Scheibe "Falke") or "staggered" side-by-side layout (e.g. Schneider "Kookaburra"). In these machines, the controls are duplicated, but instruments are shared.

*A Schneider "Kookaburra", with staggered side-by-side seating, the right-hand seat being about 35 cm behind the left-hand seat*

## THE PRE-SOLO TRAINING SYLLABUS

The syllabus of pre-solo training appears below. The assumption is made that the person undergoing training has no prior experience. If they have prior experience, e.g. in powered aircraft or ultralights, suitable adjustments to the training may be made.

Air experience. Self-explanatory, but it should be noted that some demonstration of control functions and an opportunity to "have a go" should form part of this flight.
Orientation. This flight stresses the third dimension, important for a person who has very likely spent his or her life entirely in two dimensions.
Stability. The stable platform.
Pre-take-off checks.
Primary effects of controls and the straight glide.
Secondary effects of controls.
Turning.
The launch, winch, autotow, aerotow or self-launch.
Pre-stalling, spinning and aerobatic checks.
Stalling.
Stalling in turns - the incipient spin.
Spinning.
Circuit procedures and planning.
Circuit variations.
The approach and landing.
Launch emergencies.
Flying without instruments.
First solo and post-solo consolidation.
"A" Certificate check flight.
Oral examinations for "A" Certificate.
Application to FAI Certificates Officer for "A" Certificate.

During the training prior to first solo, soaring skills are taught on an opportunity basis.

## POST-SOLO TRAINING

For the B Certificate, follow-up training is necessary to build on the skill learned pre-solo and to acquire new ones.

The post-solo training syllabus is as follows:-

Reinforcement of stalling sequences.
Reinforcement of incipient and full spinning sequences.
Reinforcement of launch emergencies.
Problem circuits (flying without instruments, running out of height, different circuit directions, etc).
Cruising and descending on aerotow.
Use of flaps and retractable undercarriage, if not covered pre-solo.
Landings with different airbrake settings, including full-brake and no-brake.
Sideslipping.
Steep turns.
Unusual attitudes.
Aerobatics (optional).
Thermal centring techniques and most efficient use of lift.
Launch speed signals, if not covered pre-solo.
Crosswind takeoffs and landings.
Correct radio procedures.

Revision of air legislation.
Airways procedures.
Application to FAI Certificates Officer for “B” Certificate when all requirements have been met.

As a pilot progresses toward the “C” Certificate, further training is carried out to prepare a pilot for the possibilities of carrying family/friend passengers and attempting the first cross country flight. The training for the C Certificate will concentrate on efficient soaring, passenger awareness and the procedures to be adopted for outlandings.

## GUIDE FOR POST-SOLO SELF-IMPROVEMENT

The formal post-solo training syllabus may be supplemented by a bit of self-help. Solo flying is a good opportunity to set definite goals and improve skills, especially in things like thermal centring and efficient soaring. If you have a “B” Certificate, fly with someone else who also has a B (or higher) qualification - you may be surprised how much you can learn from someone else's approach to a problem or indeed from someone else's mistakes (as long as the mistakes are not serious ones!).

Try flying at a different club, with different types of gliders and maybe a different launch method. It really improves flexibility as a pilot, and its fun.

Get some dual flying at your own club and try landing at different parts of the field. Each time you do it, get the instructor to comment upon the quality of your circuit. This is a useful preparation for actual outlandings, but should not be regarded as a substitute for them.

In addition to the flying, get some practice in the following:-

Reading WAC charts and the various CAA charts relevant to our activities. See chapter on navigation.
Interpreting synoptic charts and temperature traces.
Preparing barographs and turning-point cameras.
Preparing and towing trailers (with special emphasis on reversing).
How to use a radio correctly, with a view to obtaining a GFA radio-operator's logbook endorsement. See chapter on radio procedures.
Talk to experienced cross-country pilots about crops, SWER lines and how to recognise good landing paddocks from the air.
Buy a copy of the FAI Sporting Code, Section D (Gliders) from the FAI Certificates Officer, and study it.
Ask an instructor what it is like to fly a glider with rain on the wings. Don't go cross-country until you know the answer.

# CHAPTER 3 - BASIC THEORY

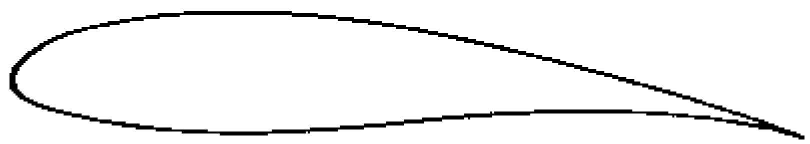
A glider is defined by the FAI as “a fixed-wing aerodyne without a power source”.

## LIFT

Like all aerodynes, a glider derives its lift from the movement of its wings through the air.

This movement through the air causes the air to flow in a particular pattern around the wings and the wings are shaped in a special way to take advantage of this flow.

The wings of any aircraft, including gliders, are of a cross-sectional shape designed to give the maximum chance of producing lift. This shape, curved or cambered over the top surface and relatively flat underneath, is known as an “aerofoil” section and the exact shape of an aerofoil depends upon what kind of aircraft we wish to apply it to. Gliders, being low speed aircraft with a speed range of 30 to 150 knots, have wings of an aerofoil section which will produce high values of lift at those low speeds without producing too much drag which would retard the machine's progress through the air. Such a wing is usually relatively thick. High-speed aircraft are a different story; their wings are very thin and not at all suited to low-speed flight. When high-speed aircraft need to fly slowly for take-off and landing, they can call upon complex high-lift devices to help them. Such complication is unsuited to gliders, although some research gliders are quite complicated and even a few production gliders in the Open Class are no longer simple.



A typical glider aerofoil section is shown here. Such an aerofoil section meets the requirements for glider design and variations on this basic theme may be considered typical for nearly all glider wings.

A wing produces lift in three different ways.

> Firstly, by its actual shape, which encourages a speeding up of the airflow over the cambered top surface. This in turn results in a lowering of the pressure over the top of the wing (Bernoulli's theory), in effect causing a “suction” upwards. Generally speaking, the thicker the wing and the more pronounced the camber, the more lift will be produced at a given speed.
>
> Secondly, by the actual speed of the wing through the air - the faster the speed, the more lift is produced.
>
> Thirdly, by the angle at which the wing meets the air. This angle, known as the Angle of Attack (AoA), has an important effect on the amount of lift produced by the wing, the lift increasing with an increase in AoA.

The first of these three points, the shape of the aerofoil section, is established by the designer and there is nothing the pilot can do about it except in a very restricted sense if the glider happens to be equipped with flaps. See page 19. Angle of attack and speed are very much under the control of the pilot and a great deal of a glider pilot's training is concerned with a good understanding of keeping both of these factors under control.

The lift developed by an aerofoil section acts at approximately right-angles to the airflow. The point on the wing through which the lift acts is called the Centre of Pressure (CP). The CP moves forward with an increase in AoA and backward with a decrease in AoA.

## WEIGHT

The weight of a glider is kept as low as possible consistent with adequate strength. Chapter 7, Basic Airworthiness, covers this in more detail. The lift produced by the wings acts in opposition to the weight of the whole glider. It will therefore be apparent that the lighter the structure and the bigger the wing, the lower will be the resultant rate of sink.

The weight always acts at right angles to the earth's surface, no matter which way the glider is pointing. The point on the glider through which the weight acts is called the Centre of Gravity (CG).

## WING LOADING

Wing loading is quite simply the flying weight of the glider divided by the wing area. “Flying weight” is defined as the weight of the glider, plus pilot, parachute, barograph, etc.

The lower the wing-loading, the lower the sink rate and the easier the glider will stay up in weak lift. The higher the wing-loading, the greater the sink rate and the stronger the lift necessary to stay aloft. However, a higher wing loading can sometimes be an advantage for flying fast between thermals, provided the thermals are strong enough to allow the glider to climb in the first place.

Here are some examples of wing-loadings.

Schleicher ASK13 two-seat trainer (flown dual):-

| | |
|---:|---|
| Wing area: | 17.5 sq. metres, 188.4 sq. feet |
| Maximum flying weight: | 480 kg, 1058 lbs |
| Wing-loading: | 27.4 kg/sq. m. 5.61 lbs/sq. ft. |

Glasflugel H303 Mosquito (including water ballast):-

| | |
|---:|---|
| Wing area: | 9.86 sq. metres, 106.1 sq. feet |
| Maximum flying weight: | 450 kg, 990lbs |
| Wing-loading: | 45.6 kg/sq.m.,8.72 lbs/sq. ft. |

Lockheed F-104G Starfighter:-

| | |
|---:|---|
| Wing area: | 18.22 sq. metres, 196.1 sq. feet |
| Maximum flying weight: | 13054 kg, 28779 lbs |
| Wing-loading: | 716.46 kg/sq.m.,146.75 lbs/sq. ft. |

The K13 and the Mosquito, at their wing-loadings, have very moderate sink rates, although the Mosquito (ballasted for fast cross-country flying) will sink somewhat faster than the K13. The Lockheed Starfighter, if its engine stopped, would have the sink rate of a greased housebrick.

# DRAG

## Profile drag

The shape of a glider offers resistance to its passage through the air. Its actual profile governs the amount of resistance, or drag it produces at any given speed through the air. This so-called “profile drag” is actually a combination of the drag caused by the shape (form drag) and that caused by any roughness of the aircraft skin (skin friction) Form drag is reduced by streamlining - by making the non-lifting parts of the glider (fuselage, etc) of such a shape as to offer the least possible resistance to the air. Skin friction is reduced by keeping the surfaces of the glider as smooth as possible, even to the extent of polishing them in some cases.

Profile drag increases as glider speed increases. However, the picture is worse than you might think. Profile drag actually increases as the square of the speed. Double the speed, four times the drag; three times the speed, nine times the drag, etc. It is obviously in everyone's' interest to make the glider as streamlined as possible and to keep its surface skin smooth and clean. It certainly explains why modern gliders are so slim and their surfaces so highly polished.

## Induced drag

There is another source of drag which must be considered. This kind of drag is inseparable from the process of producing lift from the wing and it is proportional to the angle of attack (AoA) of the wing. Because the drag is induced by the lift-producing process, it is naturally known as induced drag.

Generally speaking, in a glider, a high angle of attack means a low speed, unless “G” forces are being produced, a special case which is beyond the scope of this book. Conversely, a low angle of attack means a high speed. Induced drag therefore gets less as the glider's speed increases, the opposite effect to that occurring with profile drag. Induced drag in fact increases as the inverse square of the airspeed - double the speed, a quarter of the induced drag, etc.

## Total drag

The total drag of the glider is therefore a combination of profile and induced drags. When glider speed is changing, one kind of drag is increasing while the other is reducing. There is only one speed at which both kinds of drag are at a minimum - the speed is known rather obviously as the Speed for Minimum Drag.

Drag forces act backwards, parallel to the line of the airflow.

## Aspect ratio

A glider designer needs to reduce drag to a minimum. Profile drag will be reduced by careful streamlining and attention to the joining of the wing and tail with the fuselage. Induced drag can be reduced by making the glider wings of a particular planform.

At glider speeds, considerable reductions in induced drag can be achieved with wings of long span and narrow chord (“chord” is the distance from leading edge to trailing edge). Such wings are said to have a high **aspect ratio**.

Aspect ratio is simply defined as wing span divided by average wing chord (an average value is needed because most wings are tapered). Examples of glider aspect ratios are just under 10 for a Shortwing Kookaburra (not an aerodynamically efficient glider) to over 28 for a Nimbus 2 (which certainly is efficient). Compare this with 9.4 for the Airbus A320, by airliner standards a known efficient performer.

**Winglets**

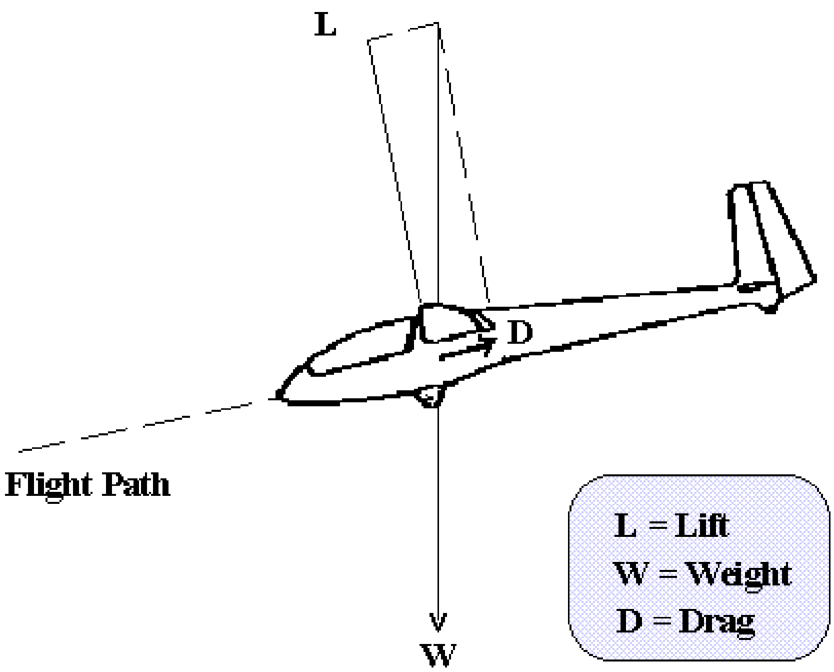
Although a high aspect ratio means low induced drag and very efficient performance, it has a structural penalty. Very long wings of high aspect ratio exert a large bending moment about the wing-root attachments to the fuselage. This can limit the extent to which the designer can (literally) spread his wings.

It has been discovered that a similar effect to increasing aspect ratio, but without quite the same structural penalty, can be achieved by bending the wingtips upwards by varying amounts, in some cases up to 90 degrees. The portion bent upwards, which may be anything up to half a metre in length, is known as a winglet.

Winglet design is by no means simple. Winglets must save more in induced drag than they produce as profile drag. The devices are popular on almost all competitive gliders, so it is assumed they do actually have some benefit. There are also reports that they have a beneficial effect in low-speed handling and reduction of stall speed in some designs.

## HOW A GLIDER ACHIEVES FORWARD FLIGHT

Once a glider has been towed aloft by one of the methods of launching described earlier, its only means of propulsion is the force of gravity. From the point of release a glider is constantly losing height in order to maintain forward speed. The more the nose is tilted downward, the more speed is given to the glider, but at the same time the more height is lost in the process. In practice, for the most efficient angle of glide, the nose of the glider is tilted downward by a very small amount, barely noticeable to the onlooker. Modern gliders can achieve very high speeds at very moderate nose-down angles. The diagram which follows illustrates the forces at work around a glider and the resultant “nose down” flight path is a bit exaggerated to show the principle.




From the pilot's point of view, this nose position in relation to the horizon is known as the glider's “attitude”. Flying by the attitude of the glider's nose to the horizon is far more important than anything the glider's instruments say.

It is important to realise that, even when a glider is gaining height in free flight, such as soaring in a thermal, it is only doing so because the thermal is ascending at a greater rate than the glider is descending through it. A glider is always descending in free flight and the pilot's job is to find air which is rising at a greater rate than the glider's descent rate.

## Minimum sink rate

The higher the wing-loading, the higher will be the rate of sink of the glider. Wing-loadings such as those which appeared earlier in this chapter are typical of the variations seen in the wide variety of glider types produced over the years. At any given wing-loading there is only one speed at which the minimum sink rate will be achieved. This occurs at about 7 knots above the stalling speed at any given weight and is known rather obviously as the Minimum Sink Speed. It is the speed at which the glider should be flown to stay in the air for the longest possible time, not necessarily to achieve the greatest possible distance on a cross-country.

## L/D ratio

The ratio between the lift produced by the wing and the drag produced by the whole airframe is critical in a glider. The designer (and the pilot) looks for as much of the former and as little of the latter as possible. Of course there is a compromise and we end up with L/D ratios suited for particular purposes. For example, a competition glider with a very high L/D ratio might be so streamlined that it would be difficult for a large person to fit into its narrow cockpit, whereas a two-seat trainer will be less streamlined because of the need to accommodate two pilots.

A highly streamlined glider with a high aspect ratio will have a high L/D ratio. This means that it loses very little height for much gain in forward distance. In other words, its “glide-angle” is very flat.

The term “glide-angle” can be considered interchangeable with “L/D ratio”. Nowadays a glide angle of 1 in 30 (1 metre height loss for 30 metres of forward gain) would be considered the minimum acceptable value for a single-seater. The very best Open Class gliders are now producing nearly 1 in 60. Note that, for any given glider weight, the maximum achievable L/D ratio occurs at only one speed, which will usually be higher than the speed for minimum sink rate.

# GLIDER STABILITY AND CONTROL

## Glider stability

These two words “stability” and “control” are very important when talking about any aeroplane, and gliders are no exception. Stability means that the glider must be able to fly for short periods of time without the pilot touching the controls. If it can do this, it means it is a good safe design which will not be too difficult or demanding to fly. Control means the opposite of stability - it means that the glider should be manoeuvrable about all of its three axes of movement (pitch, roll and yaw), using its controls.

If a glider is too stable, it is not very manoeuvrable and is tiring to fly. If it is not stable enough, it is difficult or even dangerous to fly. The designer has to produce a glider with just the right amount of each of these qualities so that it is stable enough to allow us to take our hand off the stick (to unfold a map, for example) without changing our flight path very much, yet still be very manoeuvrable when we want it to be.

The first thing a glider pilot learns when starting training is stability. The instructor will demonstrate that the glider will easily maintain level flight without the pilot's help and even if it is disturbed by turbulence it does not do anything alarming. If the nose moves up or down a bit in rough air, it does so very slowly and the same applies if the glider rolls or yaws a bit. Let us see how it achieves this stability.

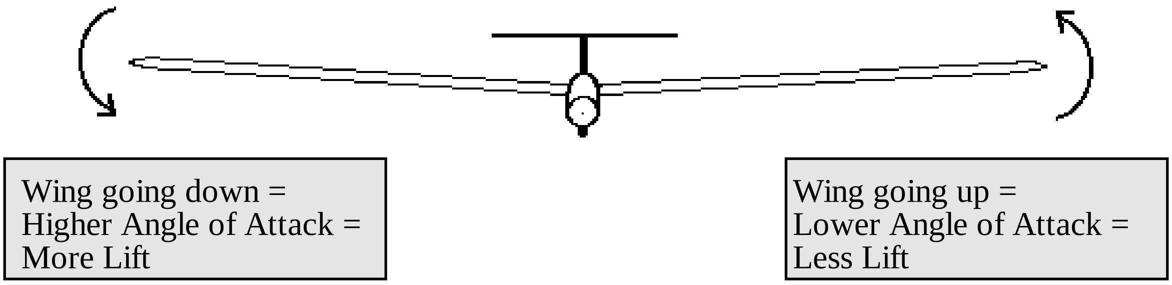
### *Longitudinal stability or stability in the pitching plane*

*The tailplane provides pitch stability*

The diagram above shows that the tailplane (or horizontal stabilizer) is like a small wing placed at the rear of the glider. This is exactly what it is, and it will produce an upward or downward force to make the nose go back to where the pilot originally put it, if it should get moved from that position for any reason. If the nose tries to go up, the tailplane forces it back down again. If the nose tries to go down, the tailplane makes it go up again. Pitch stability in gliders is provided by the tailplane.

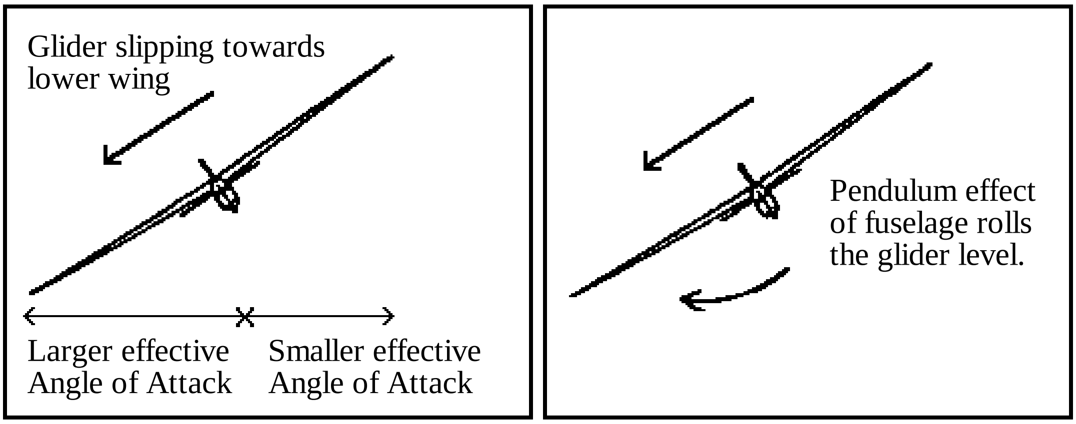
### *Lateral stability, or stability in roll*

Stability in roll, known as lateral stability, is best considered in two parts. The first part is when the glider is actually rolling or banking, either because it has been tipped by a gust or because the pilot has made it roll. When the glider rolls, there is a difference in the amount of lift produced by each wing.  The wing going down will produce more lift than the wing coming up, because of the difference in their angles of attack. This tends to damp the rolling of the glider and for this reason is known as **lateral damping.** Lateral damping is a very important factor in roll stability and it is always present as long as the wing is not stalled. If a stall occurs, lateral damping can be lost and this may spell trouble for the unwary pilot.




## Lateral damping

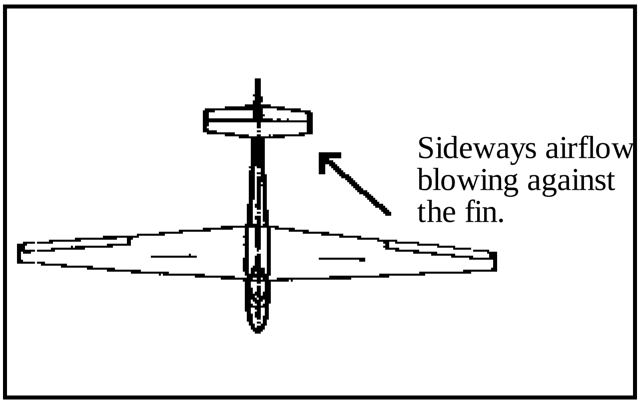
The second part of lateral stability comes into effect when the glider has stopped rolling and is stuck at a particular bank angle. A combination of dihedral effect of the wings and pendulum effect of the fuselage will help restore the glider back to level flight. The diagrams below illustrate both effects.




## Dihedral and pendulum effects

### *Directional stability or stability in yaw*

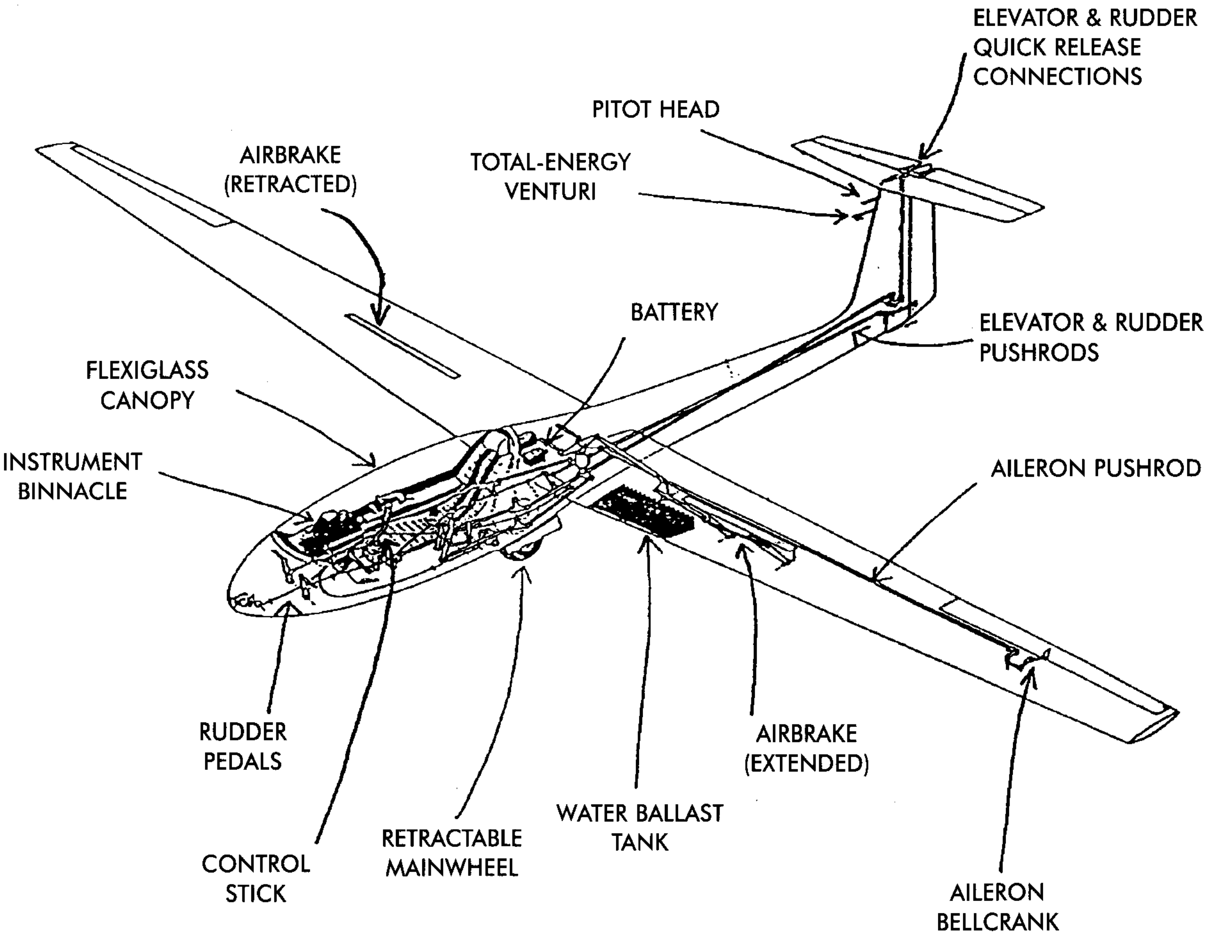
Stability in yaw, known as directional stability, is provided by the fin. When a glider yaws, the airflow blows against the side of the fin, producing a force which pushes the glider back into straight flight. This is similar to the behaviour of a weathercock on a church steeple, and in fact this kind of stability is sometimes known as weathercock stability. The fin provides directional stability.



## Glider control

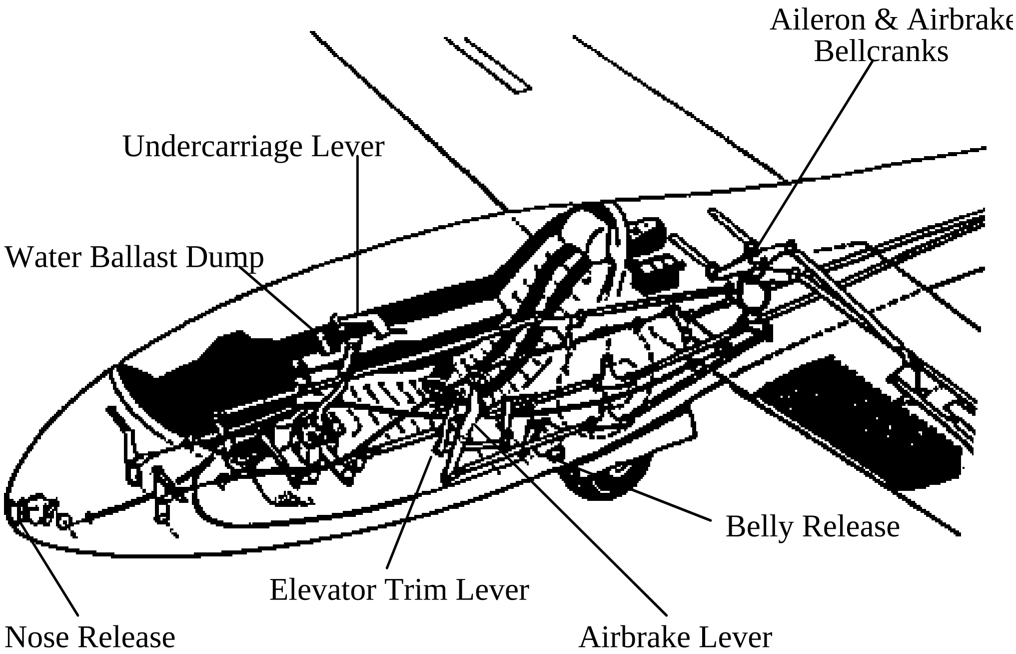
***A glider is a stable platform which can be readily controlled.***

The primary controls of a glider are the same as any other aeroplane. The elevator and ailerons are controlled by the stick and the rudder is controlled by the rudder pedals. The elevator is trimmed, either by a trim-tab or by a spring, and the airbrakes are used to control the rate of descent on the final landing approach. The diagram below shows the various controls and how they are installed and connected up in a glider.




GROB ASTIR GS STANDARD CLASS SAILPLANE

The close-up view of the cockpit of a glider which is shown here gives a more detailed picture of the operation of the control system of a modern glider.




In addition to the familiar stick and rudder pedal controls, note the additional controls positioned around the cockpit sides, one or two of which would seem a bit strange to a power-pilot's eyes. These are the airbrake control, on the left side of the cockpit, with the elevator trim right next to it. In this example, the elevator trim control is not connected to a tab, as in most light aircraft, but to two springs which are used to provide a trimming force on the elevator without the complication and drag of a tab. On the right of the cockpit is the large undercarriage retraction lever, which pulls the mainwheel up into a well behind the pilot. Just in front of the undercarriage lever is a smaller lever, which is used to dump water from the ballast tanks in the wings. The water is carried in order to increase the wing-loading for fast cross-country flying.

There are two towhooks, one in the nose for aerotowing and one under the belly for launching by winch or motor-car. They are both operated by a single knob in the cockpit.

The pilot is provided with a four-point safety harness, which gives good security during aerobatics and good protection in the event of an accident. A parachute is usually worn in this kind of glider and the cockpit canopy is easily jettisoned by means of a knob on the console under the instrument panel.

All the controls have quick-release connections, so that the glider can easily be de-rigged for transport in its trailer. Rigging the glider takes only about ten minutes and needs only three people. Safety inspections are always carried out after the glider has been rigged.

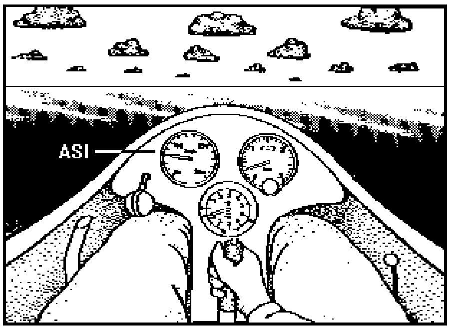
## PRIMARY EFFECTS OF CONTROLS

### Elevator

The effect of the elevator is to control the pitch of the glider. Firstly the glider is placed into its correct attitude with respect to the horizon. “Attitude” is the standard gliding term used to describe the position of the nose in relation to the horizon. When this is done, we have our “stable platform” referred to earlier. The illustration below shows how this appears from the cockpit of the glider.

Note nose position relative to horizon

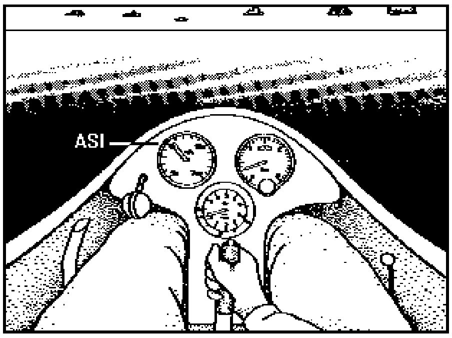
Note ASI reading




To observe the effect of the elevator, the stick is held lightly in the right hand and moved smoothly forward. Note that left-handed persons will need to get used to using the right hand on the stick. Look ahead at the horizon while doing this and it will be observed that the nose will go down below the previous attitude. The sound level in the cockpit increases as the speed builds up, due to the increase in speed of the airflow past the cockpit. During training, this sound level is a very important clue to changing speed in a glider. The increase in speed is confirmed by a glance at the Air Speed Indicator (ASI). See illustration below.

Nose lower than previous diagram

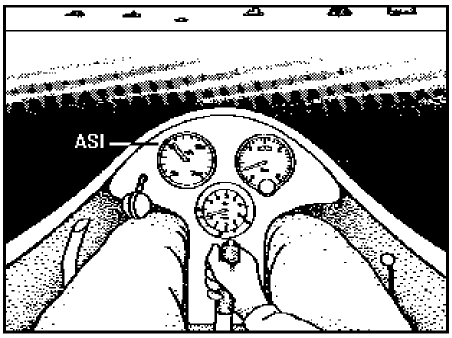
ASI reading higher




Still looking ahead, the stick is brought smoothly back and the nose will come up. The airflow noise will decrease and a glance at the ASI shows that the speed is decreasing. See below.

Nose higher than normal

ASI reading lower



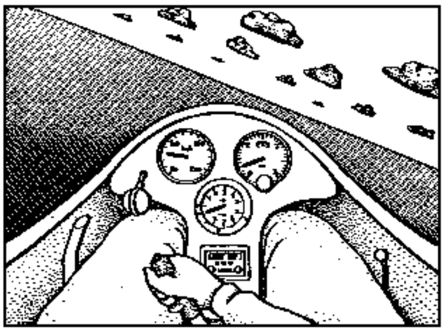

The elevator controls the attitude of the glider and therefore controls its speed. If the nose is low, the glider dives and the speed is high. If the nose is high, the glider flies slowly.

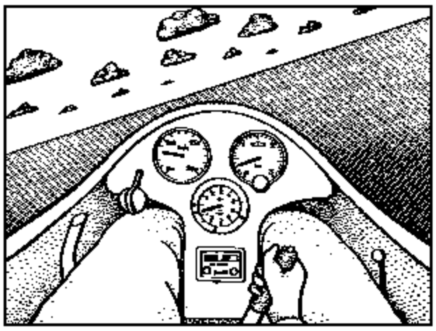
Stick forward, nose down, speed increases. Stick back, nose up and speed decreases. This is the only effect of the elevator. In a glider, **ATTITUDE = SPEED.**

## Ailerons

The effect of the ailerons is to control the bank or roll of the glider. Starting at the stable platform again, the stick is held lightly in the right hand and moved smoothly to the left. The left wing will go down and it will keep going down if the stick is kept over to the left. If the stick is brought back to the central position (this is called "centralizing" the stick) the glider will stay banked over to the left - it will not return to the wings-level position of its own accord. If the pilot wants to get the wings level, the stick has to be moved in the opposite direction, in this case to the right. When this is done, the glider will start rolling to the right until it reaches the level position. The stick is then once again centralized and the glider will remain steady with its wings level. The glider is back at the stable platform.

It will be obvious that the same principles apply to banking to the right.





To recap, stick to the left and the glider banks to the left. Stick to the right and the glider banks to the right. The glider does not return to the level position when the stick is centralized - it stays at the bank angle chosen by the pilot. The stick needs to be moved in the opposite direction if the pilot wants to return the glider to level flight.

The primary effect of the ailerons is therefore bank or roll. It is necessary to bank the glider in order to make it turn. The ailerons are therefore the TURNING CONTROLS.

## Aileron drag and adverse yaw.

Because of their long wingspan, fairly large ailerons and generally low operating speeds, gliders suffer from another effect of ailerons which becomes apparent as soon as they are used.

When the ailerons are deflected to make the glider bank, we get the results we want because the ailerons change the shape (aerofoil section) of the outer part of the wing. This in turn changes the amount of lift produced by each wingtip. For example, moving the stick to the left moves the left aileron up and the right aileron down. Lift over the left wingtip is reduced and lift over the right wingtip is increased. The glider therefore banks to the left. This is the effect we want and that's fine.

Unfortunately, an increase in lift brings with it an increase in INDUCED drag, and the effect of this is to YAW the glider in the opposite direction to which it is being banked. This unwanted yaw is adverse to the direction we want to bank, and for this reason is known as ADVERSE YAW. Adverse yaw, caused by aileron drag, is present on all gliders and cannot be eliminated. Glider pilots must therefore learn how to cope with it.

## Rudder

The effect of the rudder is to control the yaw of the glider. Once again we start at the stable platform. Moving the right rudder-pedal forward (which naturally causes the left one to move back) results in the nose of the glider yawing (swinging) to the right.

One thing that is noticeable is that, when rudder is applied, the nose will only swing so far and then it will stop. This is because the rudder has only a limited ability to yaw the glider before it comes up against the yaw stability provided by the fin. Even though the rudder-pedals are kept deflected, the nose will only yaw so far and no further. This is the first clue that the rudder is not the control which turns the glider. The primary turning control is the aileron, not the rudder.

There is usually not much need for a pilot to yaw the glider during flight, although there might be some need to use the rudder to PREVENT yaw, in rough air for example. The really useful purpose of the rudder is to act as a helping or "balancing" control to cancel out the adverse yaw caused by the aileron drag described in the previous section. Every time the ailerons are used, either to turn the glider or to keep it on an even keel when it gets tipped up in rough air, the rudder is used in the same direction at the same time to prevent the nose yawing in the "wrong" direction.

This use of rudder in combination with the ailerons is known as "coordination". The coordination of the feet with the right hand is a very important part of learning to fly gliders.

It is mentioned above that the rudder may be used to prevent yaw developing, as well as to actually produce yaw. This principle is in fact true of all the controls in their respective axes of operation. For example, rough air can cause changes in nose attitude or bank angle and the appropriate control can be used to resist this unwanted change.

### Definitions of control functions

Elevator is used to change speed or to STOP a change in speed.

Ailerons, suitably coordinated with rudder, are used to change direction or STOP a change in direction.

Rudder, as well as being used in coordination with ailerons, is used to yaw the glider or STOP the glider yawing.

## SECONDARY EFFECTS

It has already been stated that the elevator has only one effect and does not have any further, or secondary, effect. This section is therefore concerned only with the secondary effects of bank and rudder.

### Bank

If the glider is banked to one side or the other, but for some reason a properly-balanced turn does not follow, it is possible for a "sideslip" to develop towards the lower wing. If this happens, dihedral and pendulum effects (see lateral stability) will try to return the glider to straight flight. However, before this occurs, the slipping of the glider towards the lower wing will cause the glider's directional stability to yaw the nose towards the lower wing. The secondary effect of bank may therefore be YAW in the same direction as bank. It does however take some time to have any effect and is seldom encountered in practice. However, if it does develop and remains unchecked, it can eventually result in the glider entering a spiral dive.

### Yaw

Secondary effect of rudder is roll in the same direction as yaw. When rudder is applied, the nose yaws to the side. If, for example, left rudder is applied, the nose swings to the left and this effectively increases the angle of attack of the right wing, which is now tending to point its tip into the oncoming airflow. The right wing therefore produces more lift than the left one and this results in the glider banking to the left, in the same direction as the applied rudder. This effect is used in radio-controlled model aircraft to turn the model when there may not be enough radio channels to enable ailerons to be fitted. Although it is very effective on models, it is nowhere near as effective on full-size gliders and can in fact be hazardous. It must never be used as a primary method of turning the aircraft.

## ANCILLARY CONTROLS

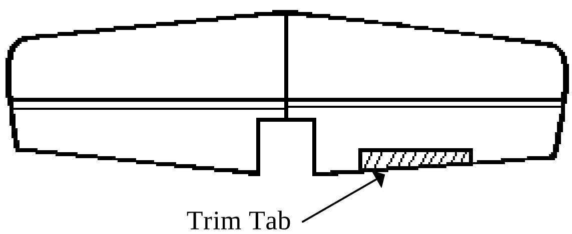
These are defined as controls other than the primary flight controls. They can be listed as follows:-

### The cable/towrope release

The definition of this control is self-explanatory. It is usually a round knob or T-shaped handle situated so as to be accessible to the pilot's left hand. In some gliders it is not as accessible as it ought to be, which is a pity because it is a vital control which sometimes needs to be located and operated quickly. Whatever its size or shape, it is always coloured YELLOW by international agreement.

### Elevator trim

The elevator trim enables the pilot to make an adjustment in order to allow the glider to be flown "hands-off" over a wide range of speeds and pilot weights. Most training gliders are fitted with elevator trim tabs, although it is nowadays more normal for high performance gliders to be fitted with a simple spring to hold the elevator in the position selected by the pilot. An elevator trim tab works as shown below. The "tab" is the small auxiliary flap inset into the trailing edge of one side of the elevator (some gliders have tabs on both sides). When deflected by the pilot moving the trim lever, the tab creates a moment about the elevator hinge line which "biases" the elevator in the opposite direction to the movement. The tab is the hatched area inset into the elevator.




The elevator trim can therefore be considered as a "labour-saving" device to save the pilot from having to keep a forward or backward force on the stick whenever he changes speed or when pilots of different weights fly the glider. The operating lever may be on the left or right side of the pilot, or in some cases even in the middle, on or near the stick. It is coloured GREEN by international agreement.

One important point about trimming. The speed of a glider is ALWAYS controlled by the elevator. The trim is used only to remove any residual force which may be felt on the stick.

Do not try to use the trim to control speed.

### Spoilers

Spoilers are flat plates which can be extended upwards from the top surface of the wing in order to steepen the final approach path for landing. They achieve their effect by "spoiling" the airflow over the top surface of the wing. Spoilers are usually not very powerful, that is they do not enable a very steep approach path to be obtained. They would therefore not be adequate for an approach into a very small paddock over a line of tall trees. Spoilers may be set at any position within their operating range as required by the pilot to achieve the desired flight path and they may be varied in position during an approach. When extended, they usually cause a nose-down change in the glider's trim, which will need to be compensated by the pilot if the approach speed is to be accurately maintained.

Spoilers are operated by the pilot's left hand and the operating lever or knob is coloured BLUE by international agreement.

*A typical spoiler installation (Scheibe SF25 "Falke" powered sailplane)*

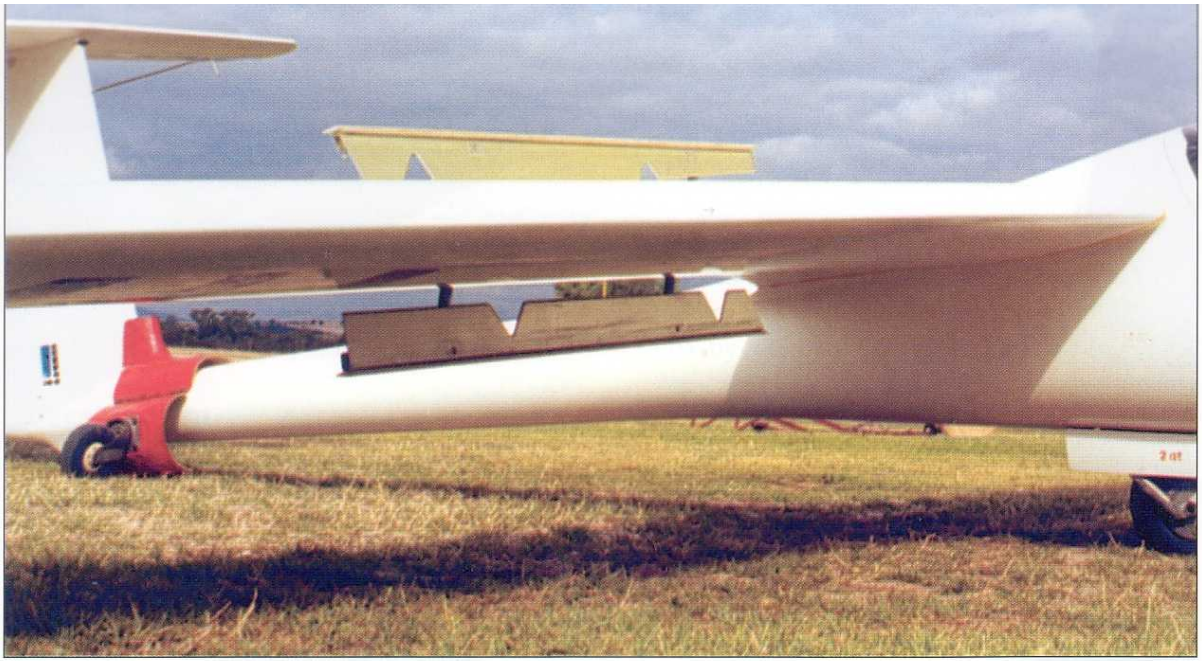
## Airbrakes

The primary purpose of airbrakes in a glider is the same as spoilers - to steepen the approach path for landing. However, they are much more powerful in their effect than spoilers, because they are generally much bigger and often extend downward from the bottom of the wing as well as up from the top. They enable the pilot to make a steeper approach to land than with spoilers and are therefore much more suitable for outlanding in very small paddocks with obstacles on the boundary. They obtain their effect partly by spoiling the lift over the top surface of the wing and partly by causing a large increase in the total drag of the glider. This in turn makes it necessary for the pilot to lower the nose to maintain a constant approach speed, thereby steepening the approach path without causing an increase in speed.

A useful side-effect of airbrakes is that they are powerful enough to act as a speed-limiting device in a dive. The airbrakes fitted to modern gliders, if fully extended, will prevent the maximum allowable speed of the glider being exceeded in a dive up to a 30 degree angle. This can be useful if accidentally caught in cloud and having to dive out without risking overspeeding the structure.

Like spoilers, airbrakes are operated by the pilot's left hand and the operating lever is also coloured BLUE, because they are used for the same basic purpose as spoilers

**Note:** Most airbrakes and spoilers, when extended, cause an increase in stalling speed of between 2 and 5 knots. Therefore they should not be "fiddled with" near the ground until a pilot has some experience and is completely familiar with the individual glider's characteristics.



*A typical "top and bottom" airbrake installation (SZD 48-1 Jantar)*

## Flaps

Quite a lot of modern gliders are fitted with flaps on the trailing edges of their wings. The purpose of flaps is to take advantage of a reduced stalling speed due to the increased camber of the wings when the flaps are lowered.

With flaps lowered, the following advantages are obtained:-

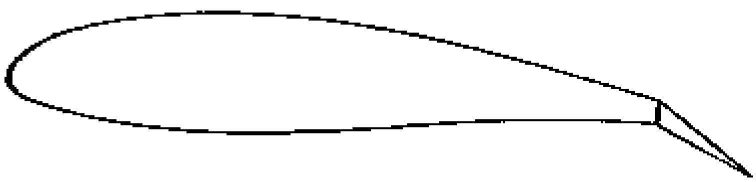
The pilot is able to fly more slowly with a good safety margin above the stalling speed.

This means a reduced radius of turn enabling small thermals to be used.

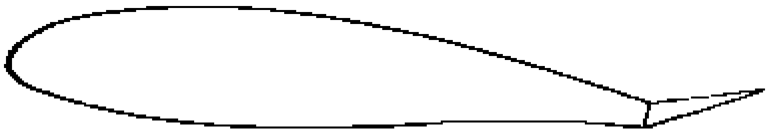
A slower approach speed may be used, still retaining an adequate margin above the stalling speed

Glider flaps also have the ability of be raised above the trailing edge of the wing into the "negative" or "reflex" position. This reduces the camber of the wing and has the effect of reducing drag at higher cruising speeds. This setting is very useful for cross-country flying.

The diagrams show the principles of operation of flaps in the downward (positive) and upward (negative) positions.



Flaps lowered. Increased camber, increased lift, reduced stalling speed, increased drag. Used for thermalling or approaching to land.

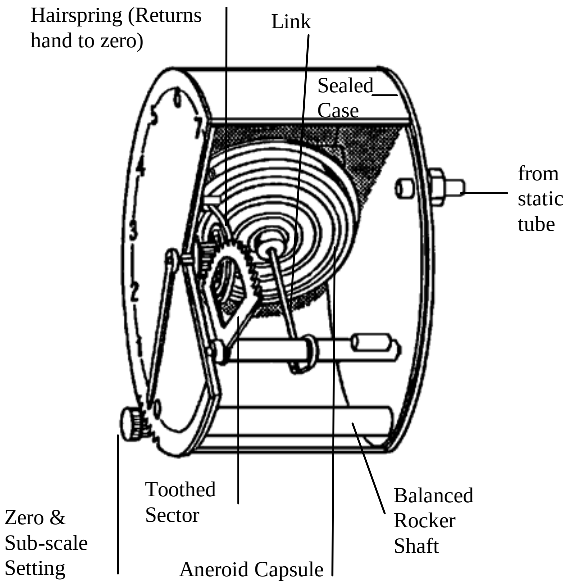


Flaps in "reflex" position. Reduced camber, less lift, higher stalling speed, reduced drag at high speeds. Used for cruising between thermals, never for circling and never for approaching to land.

## GLIDER INSTRUMENTS

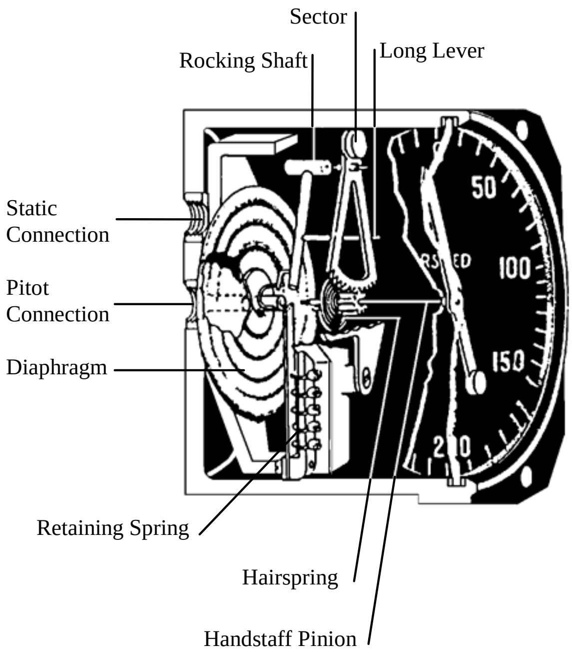
The instruments fitted to training gliders are usually quite simple, although single seaters can be more elaborately equipped, especially those used for competitions. A brief description of basic glider instruments, together with their principles of operation, follows.

### The altimeter




This instrument is simply an aneroid barometer, converted to read in feet instead of hectopascals of air pressure. Since an increase in height results in a decrease in air pressure, there is a direct relationship between the two and this can be shown clearly to the pilot. Most altimeters fitted to gliders are of the so-called "sensitive" type, which means that they have more than one hand, the better to show accurately the thousands and hundreds of feet at which the glider is flying. Similar to an ordinary domestic clock display, the large hand shows hundreds of feet and the small hand shows thousands. Many glider altimeters are of ex-military stock, purchased through disposals stores, and some of these have a third, very small, hand which shows tens of thousands of feet.

Altimeters have a "sub-scale", on which can be set the barometric pressure, using the little knob provided for the purpose. This can complicate the use of the altimeter and at this point it is best to refer to the chapter on altimetry in the GFA publication "Airways and Radio Procedures for Glider Pilots".




### The airspeed indicator (ASI)

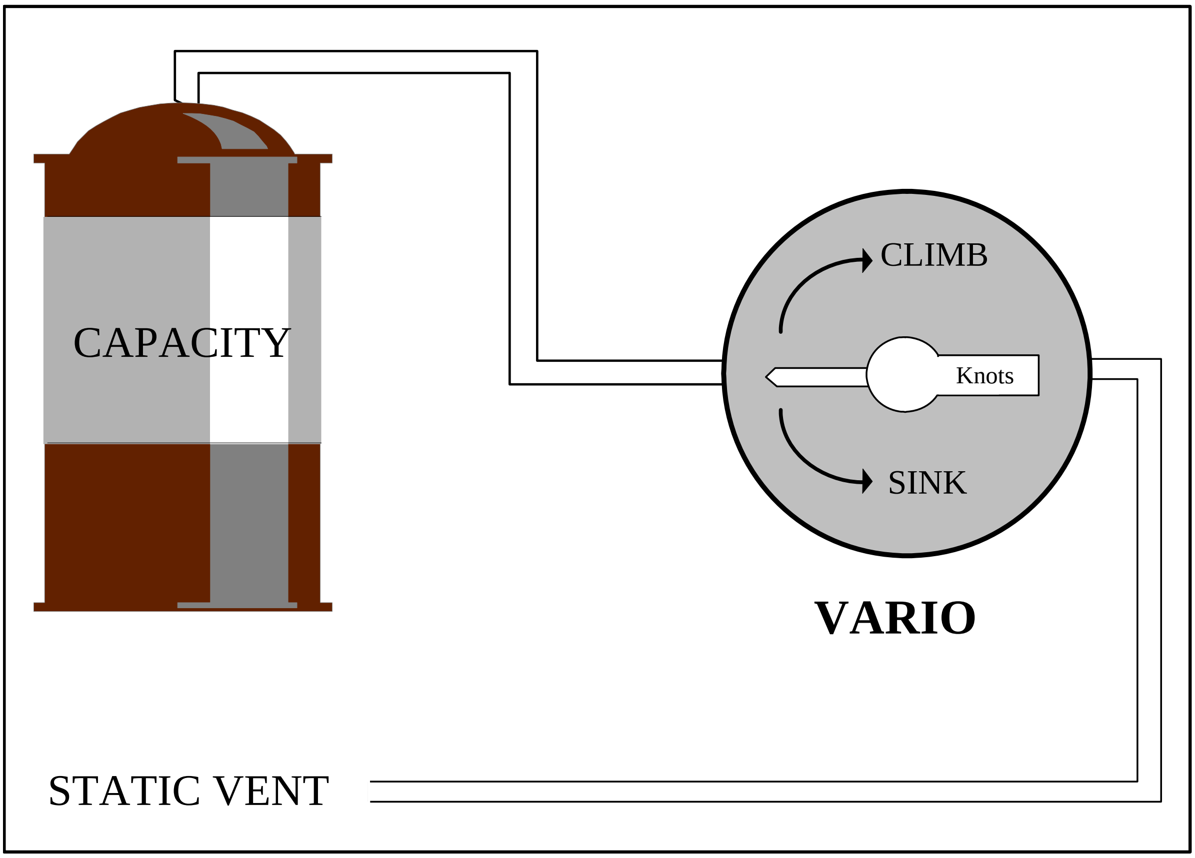
This instrument uses the pressure built up in front of the pitot head to move a needle around a dial, thus displaying the glider's speed through the air. The diagram explains how it works. Note that the pressures being handled by airspeed indicators are quite subtle and excessive pressure applied to the instrument through the pitot head will cause damage. Do not blow into pitot heads until properly taught how to do so when training to become a Daily Inspector. If you see anyone blowing into pitot heads (some people don't seem to be able to resist it), suspect that the instrument has suffered and report it to somebody.

In the lower levels of the atmosphere, where most training gliders operate, the airspeed indicator is relatively free from serious errors. However, the reduced pressure and density of the air at higher altitudes results in errors progressively creeping in. For information on these errors, refer to the "indicated airspeed and true airspeed" section in Chapter 7, Basic Airworthiness.

**The variometer**

Arguably the most important instrument in a glider, with the possible exception of the seat of the pilot's pants, the variometer is a very sensitive instrument for measuring rate of climb and descent. In its basic form, it works by measuring the rate at which air flows into and out of an enclosed container, which is a flask of standard .45 litre capacity. The air flowing in and out of the flask moves the needle in an up or down direction to indicate to the pilot whether the glider is climbing or descending.

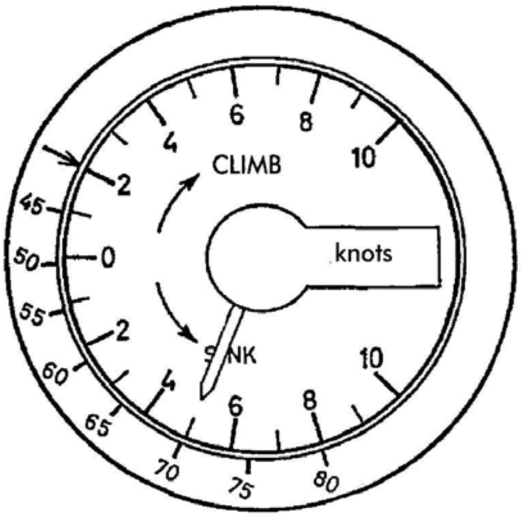
As the glider climbs in a thermal, it is moving into air of decreasing pressure. In order to equalise the pressures inside and outside of the flask, air flows out of the flask and passes through the instrument on its way. In doing so, it moves the needle to an "up" indication, by means of suitable linkages. The opposite happens when the glider descends into regions of increasing pressure.




**The McCready ring**

The American soaring pilot Paul McCready discovered that, during cross-country flying, it is possible to vary the glider's inter-thermal speed in accordance with the strength of the thermals being found. It is a simple enough theory; the stronger the thermals, the faster a pilot should fly between them in order to maximise cross-country speed.

Utilising the glider's "polar curve" of sink-rate versus airspeed, a McCready Ring can be constructed. This ring is fitted around the dial of the variometer and is controlled by the pilot. The following diagram illustrates the principle.




The arrow on the ring is rotated by the pilot to the **average** rate of climb experienced in the last thermal. Note that it is important to set it to the average climb rate, not the maximum seen by the pilot on the variometer. Most pilots are optimistic. If the ring is set too high for the prevailing conditions, the glider will be flown too fast and this may result in getting unnecessarily low on a cross-country flight and losing time by struggling back up again. In an extreme case, setting the ring too high may result in an outlanding.

Having set the ring, the pilot flies the glider in accordance with where the variometer pointer indicates in the sink range. If the pointer indicates 6 knots of sink and this shows 70 knots on the ring, accelerate the glider to 70 knots. This will of course increase the sink rate and the pointer will move further downwards. However, the situation rapidly stabilises and the pilot soon acquires the knack of varying the speed of the glider to suit the variations in sink rate, speeding up as sink increases, slowing down as sink decreases.

It might appear therefore that the progress of a glider on a cross-country flight somewhat resembles that of a dolphin. This is exactly what it does look like, and the technique of speeding up in strong sink, slowing down in lesser sink, is known as "dolphin soaring". This is often applied to the extent that, on a good day, a pilot may not bother to circle in all of the thermals, but will "dolphin soar" through most of them, only stopping to circle in one out or three or four encountered on track.

### The compass

Gliders are usually fitted with a very simple magnetic compass, although more complicated devices are available for those who must have everything.

The compass in its simple form allows the pilot to see the glider's heading through the air. For more information on practical use of the compass in flight, see the section "Use of the compass" in the Basic Navigation chapter.

# TURNING

Learning to turn a glider follows logically from learning the primary and secondary effects of the controls. More time is spent turning in gliders than in straight and level flight. It is therefore important that pilots correctly understand the forces that cause a glider to turn and how to influence those forces to achieve the desired result

## Airmanship

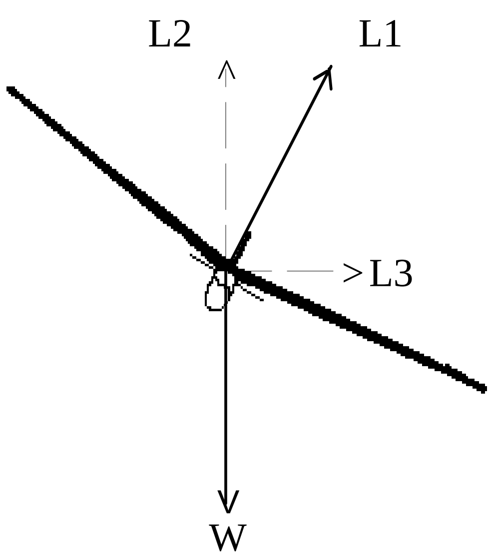
Before going on to consider the theory and practice of turning, the vital subject of airmanship must be understood. Airmanship is a difficult thing to define, but must certainly include an awareness of what is going on around the glider all the time. Pilots who possess good airmanship do not get surprised in the air, whether it be by the sudden appearance of another aircraft which had gone unnoticed or by the onset of a sudden major emergency such as tug engine failure.

The most obvious quality of airmanship from a trainee pilot's point of view, and one which is essential to acquire at an early stage, is LOOKOUT. A sharp lookout must be kept at all times. This is not difficult to do in a glider, because of the excellent visibility from glider cockpits. It is much more important in gliders than in any other kind of flying machine, except perhaps hang-gliders, because gliders are changing direction all the time in order to locate and use lift. Failure to keep a good lookout endangers ourselves and, more importantly, others sharing the air with us. For development of an effective lookout technique, see Chapter 4.

*Good airmanship is easy to acquire and its value lasts a lifetime. Bad airmanship is a menace and lasts just as long. The only difference is the length of lifetime in each case.*

Lookout is so important that an instructor will not allow a trainee pilot to turn unless that pilot has taken the basic precaution of ensuring that it is all clear. It is obvious that the main concentration of lookout will be in the direction we are about to turn; in other words towards the part of sky we are about to occupy. This careful lookout before turning must become an **INVARIABLE PRACTICE.**

Back to the turn itself. Remember that the primary turning controls are the ailerons, not the rudder. The ailerons are used to bank the glider and it is the bank angle which produces the force which turns the glider. In the diagram below, W = Weight, L1 = lift, tilted over due to bank angle, L2 = the component of lift opposing weight and L3 = component of lift producing turn.



When the glider is banked into a turn, the lift force is tilted over with it; remember that lift acts at right angles to the airflow around the wing. This tilted lift force, as well as trying to balance out the weight of the glider, also "pulls" the glider in the direction the pilot wants to turn. The more the glider is banked over, the greater the rate at which the glider will turn. The basic principle is as simple as that.

From the practical point of view, the glider is turned as follows.

Ensure a good LOOKOUT in the direction of intended turn.

Then look ahead over the nose and apply aileron and rudder together in the appropriate direction. Correct coordination can be checked by noting whether the nose moves smoothly around into the turn as the bank develops. If the nose "hesitates" before moving in the direction of the turn, insufficient rudder has been used in conjunction with the ailerons. If the nose moves noticeably in the turning direction before any bank has developed, too much rudder has been applied. The most common fault in the early stages of learning turns is insufficient rudder.

When sufficient bank has been applied (about 20 degrees is ample in the early stages of learning), centralize the ailerons and rudder. The glider will now be established in a gentle turn. Resume a lookout scan in the turning direction.

At this point you may notice a tendency for the glider's nose to drop slightly. This is normal in turning flight and is countered by a slight back pressure on the stick which must be maintained as long as the glider is turning. At steeper bank angles the nose-dropping tendency is more marked and needs a definite back movement.

During the turn, monitor and if necessary control bank angle with **A**ileron, suitably coordinated with **R**udder. Maintain correct nose attitude with **E**levator. Remember the little jingle **A-R-E**. "**ARE** we maintaining a correct turn?"

To come out of the turn, apply aileron and rudder in the opposite direction to the turn. The glider will roll towards the level position. Just before it becomes level (remember the glider has some inertia), centralize the aileron and rudder.

Relax whatever back pressure you had in the turn.

The most common faults in learning turns are -

- Failure to look out properly before turning.
- Insufficient rudder with aileron at turn entry
- Looking at ASI instead of monitoring nose attitude
- Failure to maintain back pressure in the turn.

NEVER try to turn a glider in flight by using rudder alone. Only on the ground is this acceptable.

## STALLING

A stall in straight and level flight is quite simply a progressive loss of lift over the top section of the wing, causing the glider to lose height at an exaggerated rate. It occurs because the glider is made to fly in such a way that the angle of attack of the wing becomes too great and the smooth airflow breaks down over the top surface.

It is achieved by bringing the stick progressively further and further back, slowing the glider down and increasing the angle of attack of the wing until the stall occurs.

The purpose of stall training is twofold

(i) to learn to recognise the symptoms of an impending stall and to take the appropriate action to prevent it;

(ii) should the stall actually occur, to take the appropriate recovery action.

From the pilot's point of view, the symptoms of the stall occur progressively and are as follows: -

- Nose position higher than normal. Not necessarily a great deal higher, but noticeably so.
- A continuous backward movement of the stick.
- It becomes quieter in the cockpit because of the lower speed of the airflow past the canopy.
- A falling airspeed indication on the ASI
- Flying controls are less effective.
- There may be some mild buffeting of the airframe caused by the breakdown of the smooth airflow over the wing.

When the stall occurs, the airflow around the wing looks like this: -

*The airflow in this picture (flowing over the wing from right to left) is shown by wool strips taped to the glider wing. The stall is well-developed, the strips indicating that the airflow is still normal near the leading edge (strips blowing straight back), but quite disturbed further back on the wing (strips blowing in all directions, even backwards in some cases).*

When the stall actually occurs there are three possibilities in terms of glider behaviour, depending on the type of glider.

It may drop its nose quite markedly. If this does occur, it will occur despite the stick being fully back

It may not drop its nose, even though the stick is right on the back stop. In this kind of stall (e.g. Twin Astir), the rate of descent can be very high, although the nose position gives no clue to this.

One wing may go down, i.e. the glider may start rolling. This phenomenon, known as wing-drop, may occur in either of the above two types of stall and it may happen at exactly the same time as the stall occurs or perhaps just before.

Whichever of the three types of behaviour are apparent at the stall, the same action is taken by the pilot in all cases. This action is quite simply smooth and progressive forward movement of the stick to reduce the angle of attack and "unstall" the wing. Look outside at the horizon while you are doing this, to help orientation, reduce discomfort and make it more obvious when recovery action has been effective.

There is an interesting point to consider here. Although it is quite logical that a type "2" stall (no nose drop) can be cured by forward movement of the stick to lower the nose, it is not so readily apparent why it is necessary to move the stick forward when the nose has already dropped, or how it manages to fix a dropping wing.

As far as the nose-drop is concerned, it is important to realise that the wing is still stalled despite the nose pitching down. If the stick is held back, the nose will pitch strongly up again and go into another stall; it will go on doing this until the stick is moved forward to unstall the wing. Note that this forward movement of the stick when the nose goes down is not an instinctive reaction - all your training up to this point has tended to suggest that you should do the opposite. For this reason, stalling must be practised to the extent that forward movement of the stick when a stall is recognized becomes a CONDITIONED RESPONSE.

## Loss of lateral damping

Wing drop occurs simply because one wing stalls before the other. When it stalls, lateral damping, the force which provides stability when the glider is rolling, is lost. There is nothing to stop the wing dropping further and further at the stall. In fact, the more the wing drops when stalled, the more it wants to keep dropping. In other words, the stability in roll provided by the lateral damping of an un-stalled wing becomes extreme **instability** in roll when the wing is stalled. The good news is that, when the stick is moved forward, the wing un-stalls, lateral damping is restored and the wing immediately stops going down.

A characteristic of stall recovery is that, once the stick has been moved positively forward and the angle of attack restored to below the stalling angle, the smooth airflow restores itself instantly and the wing immediately starts working in its normal way. However, care should be exercised in the use of the elevator after recovery from a stall. If the stick is pulled back too sharply too early after stall recovery, another stall could result. The average glider needs about three seconds to accelerate from the stalled condition to a safe speed of about 1.5 times the stalling speed during a normal stall recovery.

To summarise, always look ahead at the horizon during the first stages of stall recovery. Use the ASI as a back-up for ensuring that airspeed is building up. There is no point in diving in an exaggerated manner during stall recovery - it just wastes height. Develop a feel for when the glider has become unstalled and the nose can be safely restored to its normal position on the horizon.

## STALLING IN A TURN - THE INCIPIENT SPIN

The last section mentioned wing-drop at the stall. If the wing-drop remains uncorrected, that is if the pilot fails to reduce the angle of attack of the wing by moving the stick forward, the glider could enter an incipient spin. The word incipient simply means undeveloped; the trick is to stop it from developing. We now know that the way to do this is by forward movement of the stick.

That's fine, but let us now take things a bit further. Suppose we do not recognise a wing drop early enough and as a result the wing drops quite a long way before we wake up. Let's say it goes to about 40 degrees of bank. As it goes down, it generates a very large angle of attack, resulting in loss of lateral damping and a tendency to keep rolling uncontrollably. The large angle of attack also produces a lot of induced drag.

The high value of induced drag causes YAW in the same direction as the dropping wing. This is the incipient stage of a spin. It is still a much undeveloped manoeuvre and if it is recognised at this stage can be very easily brought back under control by using forward stick movement (to unstall the wing) and just enough rudder to stop any yaw which may have developed.

Note that the use of the rudder is confined to small amounts at this stage - it is much more important to unstall the wing promptly by correct use of the elevator.

Although wing drop is quite easy to recognise in a straight stall, what if the glider stalls during a turn? This can occur, for example during a thermalling turn, if a pilot tries to fly very slowly in an attempt to reduce the radius of turn and get right into the centre of the thermal.

This is a much more difficult thing to recognise, because it is possible when turning for a glider to get close to the stall without the nose being noticeably higher than normal. The reason for this is related to the fact that the inner wing in a turn operates at a higher angle of attack than the outer wing and is therefore likely to reach the stalling angle while the outer wing is still below that critical angle. This means that the first thing a pilot might know about the onset of an incipient spin from turning flight is an "uncommanded" roll in the direction of the turn. In other words the glider increases its rate of roll without any aileron input from the pilot.

This is the first sign of a stalled inner wing in a turn and it is caused once again by the loss of lateral damping as the wing stalls. It is important to realise that, of all the conventional symptoms listed as being present in a level-flight stall, the only one which may be present during turning flight is the continuous backward movement of the stick.

The recovery action in this case is the same as that used to fix a wing-drop from a straight stall. The stick is moved smoothly and firmly forward and at the same time sufficient rudder should be applied to prevent the glider yawing any further towards the dropping wing. Your attention should be directed primarily OUTSIDE the cockpit during this process. As soon as lateral damping is restored and the wing has stopped dropping, level the wings by using the ailerons and fly the glider back to its usual attitude by normal use of all the controls.

## THE FULLY-DEVELOPED SPIN

Spinning is an extension of the stalling and incipient spinning exercises. Once again, the purpose of the exercise is to acquaint pilots with the pre-spin symptoms so as to prevent the spin occurring and to expose pilots to the spin manoeuvre in order that the apprehension of spinning may be alleviated.

A spin may be defined as a manoeuvre in which the glider descends rapidly in a corkscrew flight path, with one wing completely stalled and the other wing either partially stalled or not stalled at all. Although many alarmist stories are told about spinning, it is important to realise that the recovery action is well-established and is always successful, if correctly applied.

There are three stages of a spin, as follows -

The incipient or undeveloped spin

The fully developed spin

The recovery.

The incipient stage has already been described and its recovery action dealt with. Once the fully-developed spin is achieved, however, we have an additional problem to consider, that of the actual rotation of the glider as it spins downwards. The inertia of the glider's mass rotating in the spin manoeuvre alters the nature of the recovery action. More on this in a moment.

Basically a glider spins because one wing stalls, sometimes of its own accord but usually under provocation from the pilot. This provocation usually takes the form of flying the glider too slowly (although not a great deal too slowly) and progressively applying more and more rudder in an attempt to "help" the glider round a turn.

Such wrong technique on the part of a pilot, which usually comes into play under stress, is unfortunately very common. It is also remarkably difficult to detect by any of the conventional methods of observing attitude and slip/skid. The stressful state of mind which causes this kind of regression in flying accuracy is frequently caused by trying to manoeuvre at low level, precisely the time when the consequences of a spin are at their worst.

The spin is a height-consuming manoeuvre. The height lost for each complete rotation of a spin varies from about 250ft in the case of a Kookaburra to nearly double that figure for an IS28B2 or a Janus.

Two things are therefore obvious, (i) the consequences of a low-level spin are likely to be disastrous, and (ii) practice spinning exercises are always done with plenty of height in hand and such exercises must be completed above 1000ft AGL (Above Ground Level).

The rotation in a spin is caused by the large difference in angle of attack between the inside and the outside wings. The inside wing has a very large angle of attack, total loss of lateral damping and an extremely high value of induced drag. The outside wing may be partially stalled, but observation of tufted wings in spinning manoeuvres suggests that it is usually not stalled at all.

The rolling motion in a spin ensures that the high AoA and the high induced drag on the inside wing are both maintained and this results in the glider automatically continuing to rotate in the spin. For this reason, the continuous rotation in the spin is known as AUTOROTATION. It will persist for as long as the conditions which were set up to produce the spin are maintained.

Recovery action from a fully developed spin is clear-cut and universal. Full rudder is applied in the opposite direction to the rotation, then the stick is moved steadily and progressively forward until the spin stops. At this point two problems need to be considered.

It is easy to become disorientated in the spin and become confused as to which way the glider is spinning. Practice removes most of this confusion.

The nose-down attitude in the spin is typically very steep. It is by no means an instinctive reaction to move the stick forward under these circumstances.

It is therefore necessary to practice spinning to the extent that confusion is eliminated and the recovery action, like that from a stall, becomes a CONDITIONED RESPONSE.

Once again, the sequence of actions to recover from a fully-developed spin are :-

Apply **full** opposite rudder.

Ensuring ailerons central, move the stick progressively forward until the spin stops.

When the spinning stops, centralize the rudder and recover from the resultant dive.

**Notes:**

Do not expect rudder alone to stop the rotation in a developed spin. Use of both controls is always necessary.

Because of the sideways airflow around the tail of the glider in a spin, the force required to apply full rudder is about three times that required in normal flight.

If recovery is not immediate despite correct and full recovery action being taken, don't panic. The glider will eventually recover.

Although correct spin recovery action is always successful, this is only so if the glider is flown within its limitations of weight and balance. See Chapter 7, Basic Airworthiness.

**Safe speed near the ground**

Prevention is better than cure. This is the origin of the "Safe speed near the ground" concept which is firmly locked into the GFA training system. The concept is quite simple - when under about 1000ft AGL the speed must be increased to at least 1.5 times the stalling speed (1.5Vs). This is designed to give an extra degree of protection in a situation where loss of control could leave insufficient height for recovery.

There is no flexibility in the "safe speed near the ground" rule

# CHAPTER 3 - SELF-TEST QUESTIONNAIRE

Try these questions to test your understanding of the basic theory in Chapter 3. If you have trouble, refer back to the text of Chapter 3 for help.

What is the name given to the cross-sectional shape of the wing?

What three factors affect the lift produced by the wing?

In what direction does lift act?

Define wing-loading.

Name the two kinds of drag.

What provides stability in the pitching plane?

What is dihedral and what is its purpose?

What is the speed control in a glider?

What are the turning controls?

What is adverse yaw and what causes it?

Define "coordination".

What is the secondary effect of rudder?

What is the purpose of spoilers or airbrakes?

What happens to the stalling speed when flaps are lowered?

What action must never be omitted before turning?

What are the symptoms of a stall in straight flight?

What action must the pilot take if the glider stalls?

Is it possible to stall in a turn without a nose-high attitude?

What action must the pilot take if the glider stalls in a turn?

What is the recovery action from a fully-developed spin?

Define "safe speed near the ground". Calculate the speed to fly the circuit in a glider which stalls at 33 knots in straight flight.

How would you know if you had not applied enough rudder with aileron at the entry to a turn?

What is meant by the term "autorotation"?

If you are turning and the glider starts to noticeably increase its bank angle without any input from you, what is the problem and what would be your action?

What is another name for directional stability?

Define aspect-ratio.

What kind of drag is affected by a change in aspect-ratio?

Which force provides a glider with forward speed?

What happens to the stalling speed when the airbrakes are opened?

What is the other name for "glide-angle"?

# CHAPTER 4 - THE DEVELOPMENT OF EFFECTIVE LOOKOUT

Adapted from ICAO circular 213-AN/130 (1989)

## INTRODUCTION

The practice of "see-and-avoid" is recognised as the primary method that a pilot uses to minimise the risk of collision when flying as an uncontrolled flight in visual meteorological conditions. "See-and-avoid" is directly linked with a pilot's skill at looking about outside the cockpit or flight deck and becoming aware of the surrounding visual environment. Its effectiveness can be greatly improved if the pilot can acquire skills to compensate for the limitations of the human eye. These skills include the application of effective visual scanning, and the development of habit patterns that can be described as "good airmanship".

This chapter aims to make pilots aware of the skills required to make look-out more effective and is directed towards those pilots who do their flying under visual flight rules (VFR).

A study of over two hundred reports of mid-air collisions showed that they can occur in all phases of flight and at all altitudes. It may be surprising that nearly all mid-air collisions occur during daylight hours and in excellent visual meteorological conditions. While the majority of mid-air collisions occurred at lower altitudes where most VFR flying is carried out, collisions can and did occur at higher altitudes. Because of the concentration of aircraft in the vicinity of aerodromes, most collisions occurred near aerodromes when one or both aircraft were descending or climbing. Although some aircraft were operating as instrument flight rules (IFR) flights, most were VFR and uncontrolled.

There is no way to say whether it is the experienced or the inexperienced pilot who is more likely to be involved in a mid-air collision. While a novice pilot has much to think about and so may forget to maintain an adequate look-out, the experienced pilot, having flown through many hours of routine flight without spotting any hazardous traffic, may grow complacent and forget to scan.

If you learn to use your eyes and maintain vigilance through proper awareness, it will not be difficult for you to avoid mid-air collisions. The results of studies of the mid-air collision problem show that there are certain definite warning patterns.

### Causes of mid-air collisions

What contributes to mid-air collisions? Undoubtedly, traffic congestion and aircraft speeds are part of the problem. In the head-on situation, for instance, a glider and a light twin-engine aircraft may have a closing speed of about 250 kts. It takes a minimum of 10 seconds for a pilot to spot traffic, identify it, realise it is a collision threat, react, and have the aircraft respond. Two aircraft converging at 250 kts will be less than 25 seconds apart when the pilots are first able to see each other, so it is obvious that they both need to pay attention.

The reason most often noted in the mid-air collision statistics reads "failure of pilot to see other aircraft" - in other words, failure of the see-and-avoid system. In most cases at least one of the pilots involved could have seen the other in time to avoid the collision if that pilot had been watching properly. Therefore, it could be said that it is really the eye which is the leading contributor to mid-air collisions. Take a look at how its limitations affect your flight.

## Limitations of the eye

The human eye is a very complex system. Its function is to receive images and transmit them to the brain for recognition and storage. It has been estimated that 80 per cent of our total information intake is through the eyes. In other words, the eye is our prime means of identifying what is going on around us.

In the air we depend on our eyes to provide most of the basic input necessary for flying the aircraft, e.g. attitude, speed, direction and proximity to opposing air traffic. As air traffic density and aircraft closing speeds increase, the problem of mid-air collision increases considerably, and so does the importance of effective scanning. A basic understanding of the eyes' limitations in target detection is probably the best insurance a pilot can have against collision.

The eye, and consequently vision, is vulnerable to many things including dust, fatigue, emotion, germs, fallen eyelashes, age, optical illusions, and the effect of alcohol and certain medications. In flight, vision is influenced by atmospheric conditions, glare, lighting, windshield distortion, aircraft design, cabin temperature, oxygen supply, acceleration forces and so forth.

Most importantly, the eye is vulnerable to the vagaries of the mind. We can "see" and identify only what the mind permits us to see. A daydreaming pilot staring out into space is probably the prime candidate for a mid-air collision.

One inherent problem with the eye is the time required for accommodation or refocusing. Our eyes automatically accommodate for near and far objects, but the change from something up close, like a dark instrument panel two feet away, to a well lighted landmark or aircraft target a mile or so away, takes one to two seconds. That can be a long time when you consider that you need 10 seconds to process the necessary information to avoid a mid-air collision.

Another focusing problem usually occurs when there is nothing to specifically focus on, which usually happens at very high altitudes, as well as at lower levels on vague, colourless days above a haze or cloud layer when no distinct horizon is visible. Pilots experience something known as "empty-field myopia", i.e. staring but seeing nothing, not even opposing traffic entering their visual field.

The effects of what is called "binocular vision" have been studied during investigations of mid-air collisions, with the conclusion that this is also a causal factor. To actually accept what we see, we need to receive cues from both eyes. If an object is visible to only one eye, but hidden from the other by a windshield post or other obstruction, the total image is blurred and not always acceptable to the mind. Therefore, it is essential that pilots move their head when scanning around obstructions.

Another inherent eye problem is the narrow field of vision. Although our eyes accept light rays from an arc of nearly 200 degrees, they are limited to a relatively narrow area (approximately 10-15 degrees) in which they can actually focus on and classify an object. Although movement on the periphery can be perceived, we cannot identify what is happening there, and we tend not to believe what we see out of the corner of our eyes. This, aided by the brain, often leads to "tunnel vision".

Motion or contrast is needed to attract the eyes' attention, and tunnel vision limitation can be compounded by the fact that at a distance an aircraft on a collision course will appear to be motionless. The aircraft will remain in a seemingly stationary position, without appearing to move or to grow in size, for a relatively long time, and then suddenly bloom into a huge mass, almost filling up the canopy. This is known as the "blossom effect". It is frightening that a large insect smear or dirty spot on the canopy can hide a converging aircraft until it is too close to be avoided.

In addition to its inherent problems, the eye is also severely limited by environment. Optical properties of the atmosphere alter the appearance of aircraft, particularly on hazy days. "Limited visibility" actually means "limited vision". You may be legally VFR when you have the specific visibility, but at that distance on a hazy day you may have difficulty in detecting opposing traffic; at that range, even though another aircraft may be visible, a collision may be unavoidable because of the high closing speeds involved.

Light also affects our visual efficiency. Glare, usually worse on a sunny day over a cloud layer or during flight directly into the sun, makes objects hard to see and scanning uncomfortable. An aircraft that has a high degree of contrast against the background will be easy to see, while one with low contrast at the same distance may be impossible to see. In addition, when the sun is behind you, an opposing aircraft will stand out clearly, but if you are looking into the sun, the glare of the sun will usually prevent you from seeing the other aircraft. Another problem with contrast occurs when trying to sight an aircraft against a cluttered background. If the aircraft is between you and terrain that is varicoloured or heavily dotted with buildings, it will blend into the background until the aircraft is quite close.

And, of course, there is the mind, which can distract the pilot to the point of not seeing anything at all, or cause cockpit myopia - staring at one instrument without even "seeing" it.

As can be seen, visual perception is affected by many factors. Pilots, like others, tend to overestimate their visual abilities and to misunderstand their eyes' limitations. Since a major cause of mid-air collisions is the failure to adhere to the practice of see-and-avoid, it can be concluded that the best way to avoid collisions is to learn how to use your eyes for an efficient scan.

## Visual scanning technique

To avoid collisions you must scan effectively from the moment the aircraft moves until it comes to a stop at the end of the flight. Collision threats are present on the surface, at low altitudes in the vicinity of aerodromes, and at cruising levels.

Before take-off, scan the airspace and the runway visually, to ensure that there are no aircraft or other objects in the take-off area.

After take-off, scan to ensure that no aerodrome traffic will be an obstacle to your safe departure.

Before and during any turn, focus particular attention in the direction of the turn.

Remain constantly alert to all traffic within your normal field of vision, as well as periodically scanning the entire visual field outside the aircraft to ensure detection of conflicting traffic. Remember that the performance capabilities of many aircraft, in both speed and rates of climb/descent, result in high closure rates, limiting the time available for detection, decision, and evasive action.

## How to scan

The best way to start good scanning is by eliminating bad habits. Naturally, not looking out at all is the poorest scan technique. Glancing out at intervals of five minutes or so is also poor when considering that it takes only seconds for a disaster to happen.

Glancing out and "giving the old once-around" without stopping to focus on anything is practically useless; so is staring out into one spot for long periods of time.

There is no one technique that is best for all pilots. The most important thing is for each pilot to develop a scan that is both comfortable and workable.

Learn how to scan properly by knowing where and how to concentrate your search. It would be desirable, naturally, to be able to look everywhere at once but, that not being possible, concentrate on the areas most critical to you at any given time.

Always look out before you turn and make sure your path is clear. Look out for traffic making an unusual entry into the circuit. During aerotow descent and climb-out, tug pilots must make gentle clearing turns to see if anyone is in the way.

During that very critical final approach stage, do not forget to scan all around to avoid tunnel vision. Pilots often fix their eyes on the point of touchdown. You may never arrive at the runway if another pilot is also aiming for the same runway threshold at that time.

In normal flight, you can generally avoid the threat of a mid-air collision by scanning an area at least 60 degrees left and right of your flight path. Be aware that constant angle collisions often occur when the other aircraft initially appears motionless at about your 10 o'clock or 2 o'clock positions. This does not mean you should forget the rest of the area you can see. You should also scan at least 10 degrees above and below the projected flight path of your aircraft. This will allow you to spot any aircraft that is at an altitude that might prove hazardous to you, whether it is level with you, climbing from below or descending from above.

The probability of spotting a potential collision threat increases with the time spent looking outside. To be most effective, the gaze should be shifted and refocused at regular intervals. Most pilots do this in the process of scanning the instrument panel but it is also important to focus outside the cockpit to set up the visual system for effective target acquisition. Pilots should also realise that their eyes may require several seconds to refocus when switching views between items in the cockpit and distant objects. Proper scanning requires the constant sharing of attention with other piloting tasks, thus it is easily degraded by such conditions as fatigue, boredom, illness, anxiety or preoccupation.

Effective scanning is accomplished by a series of short, regularly-spaced eye movements that bring successive areas of the sky into the central visual field. Each movement should not exceed 10 degrees and each area should be observed for at least one second to enable detection. Although horizontal back-and-forth eye movements seem preferred by most pilots, each pilot should develop the scanning pattern that is most comfortable and then adhere to it to assure optimum scanning. Peripheral vision can be most useful in spotting collision threats from other aircraft. Each time a scan is stopped and the eyes are refocused, peripheral vision takes on more importance because it is through this element that the presence of other aircraft is often detected. Remember that if another aircraft appears to have no relative motion, it is likely to be on a collision course with you. If that aircraft shows no horizontal or vertical motion on the windshield, but is increasing in size, take immediate evasive action.

### Scan patterns

Two scanning patterns described here have proved to be very effective for pilots and involve the "block" system of scanning. This system is based on the premise that traffic detection can be made only through a series of eye fixations at difference points in space. The viewing area is divided into segments, and the pilot methodically scans for traffic in each block of airspace in sequential order.

### Side-to-side scanning method

Start at the far left of your visual area and make a methodical sweep to the right, pausing very briefly in each block of the viewing area to focus your eyes. At the end of the scan, return to and scan the instrument panel and then repeat the external scan.

### Front to side scanning method

Start in the centre block of your visual field (centre of front windshield); move to the left, focusing very briefly in each block, then swing quickly back to the centre block after reaching the last block on the left and repeat the performance to the right. Then after scanning the instrument panel, repeat the external scan.

### The time-sharing plan

External scanning is just part of the pilot's total visual work. To achieve maximum efficiency in flight, a pilot also has to establish a good internal scan and learn to give each scan its proper share of time. The amount of time spent scanning outside the cockpit in relation to what is spent inside depends, to some extent, on the work-load inside the cockpit and the density of traffic outside. Generally, the external scan will take about ten times as long as the look at the instrument panel.

During an experimental scan training course, using military pilots who experience ranged from 350 hours to over 4000 hours of flight time, it was discovered that the average time needed to maintain a steady state of flight was three seconds for the instrument panel scan and 18 to 20 seconds for the outside scan. Glider pilots need even less time on the instruments, especially with audio variometers.

An efficient instrument scan is good practice, even when flying VFR. The ability to scan the panel quickly permits more time to be allotted to exterior scanning, thus improving collision avoidance.

Developing an efficient time-sharing plan takes a lot of work and practice, but it is just as important as developing good landing techniques. The best way is to start on the ground, in your own aeroplane or the one you usually fly, and then use your scans in actual practice at every opportunity.

In two-seaters, if one pilot is occupied with essential work inside the cockpit, (e.g. map reading), the other pilot must expand his scan to include both his own sector of observation and that of the other pilot; in other words the second pilot must scan ahead and to both sides of the aircraft.

### Collision avoidance checklist

Collision avoidance involves much more than proper scanning techniques. You can be the most conscientious scanner in the world and still have an in-flight collision if you neglect other important factors in the "see-and-avoid" technique. It might be helpful to use a collision avoidance checklist as routinely as you do the pre-take off and landing lists. Such a checklist might include the following items:

### Check yourself

Start with a check of your own conditions. Your eyesight, and consequently your safety, depend in your mental and physical conditions. If you are distracted before a flight, you should think twice about flying under such circumstances. Absentmindedness and distraction are the main enemies of concentrated attention during flight.

### Plan ahead

To minimise the time spend "head down" in the cockpit, plan your flight ahead of time. Have maps folded in proper sequence and within handy reach. Keep your cockpit free of clutter. Be familiar with headings, distances, etc. ahead of time so that you spend minimum time with your head down in your maps.

Check your maps, NOTAM, etc. in advance for such potential hazards as restricted areas, military low-level routes, intensive training areas and other high-density areas.

### Clean canopy

During the pre-flight, make sure your canopy is clean.

### Adhere to procedures

Follow established operating procedures and regulations, such as proper circuit practices. You can get into trouble, for instance, by skimming along the bottoms of clouds without observing proper cloud clearance.

In most in-flight collisions at least one of the pilots involved was not where he was supposed to be.

### Avoid crowded airspace

If you cannot avoid aerodromes en route, fly over them well above circuit height. Military aerodromes, in particular, should be avoided as they usually have a very high concentration of fast-moving jet traffic operating in the vicinity.

### Compensate for blind spots

Compensate for your aircraft's design limitations. All aircraft have blind spots; know where they are in yours. For example, a high-wing aircraft that has a wing down in a turn blocks the view of the area you are turning into. A mid wing blocks the area beneath you.

One or other of these limitations apply to the instructor's cockpit of most two-seat gliders.

### Use all available eyes

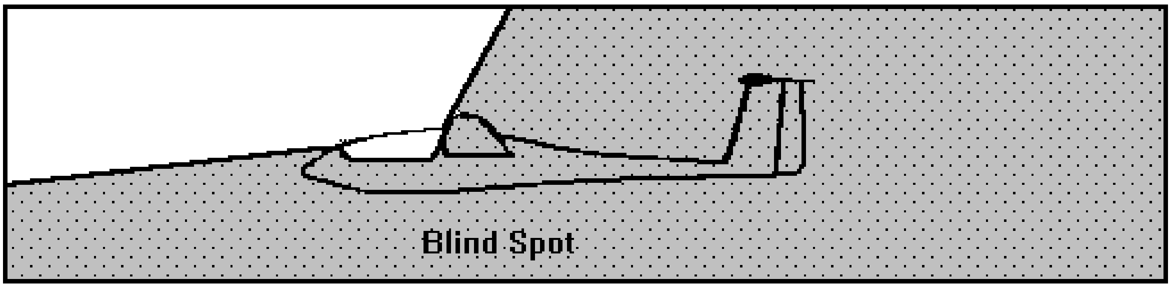
The command pilot of a two-seater will have established crew procedures which ensure that an effective scan is maintained at all times. Obtain the assistance of the other pilot to look out for traffic of which you have been made aware and monitor the movement of other aircraft which you have already sighted. Remember, however, that the responsibility for avoiding collision is yours and you must maintain your vigilance at all times.

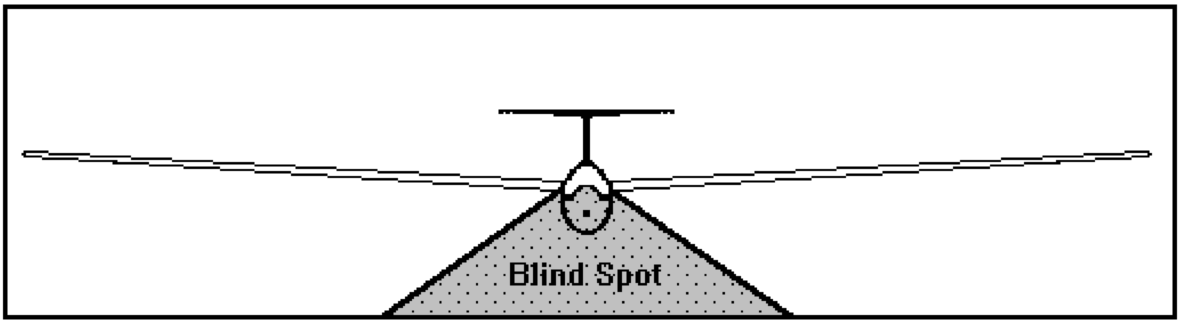
### Scan

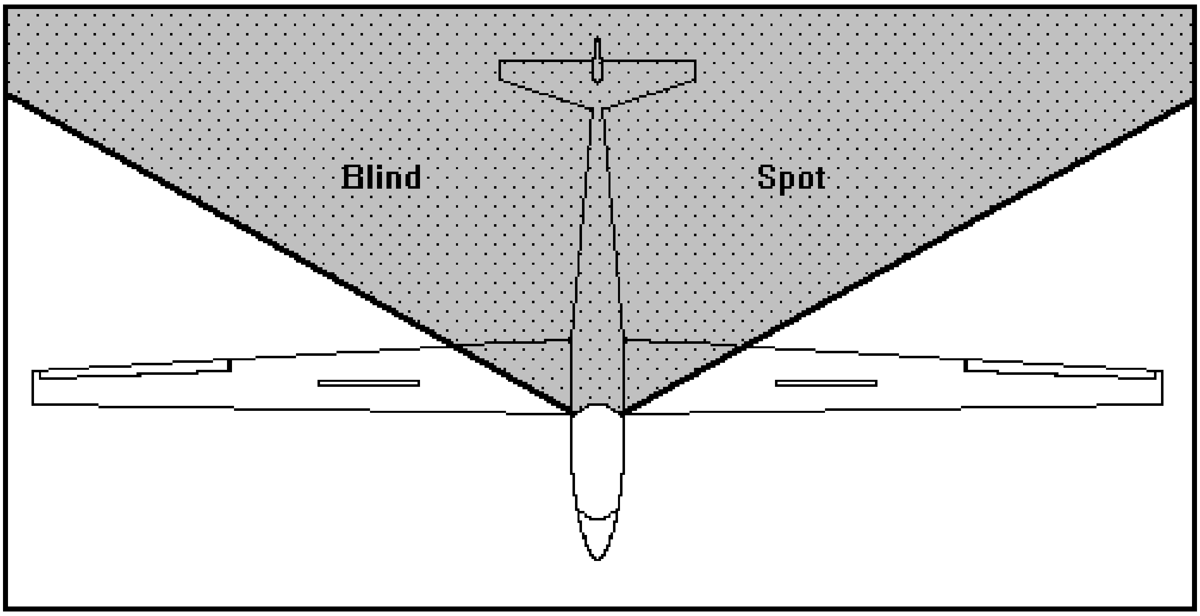
The most important part of your checklist is, of course, to keep looking out at where you are going and to watch for other traffic. Make use of your scan constantly.

If you adhere to good airmanship, keep yourself and your aircraft in good condition, and develop an effective scan time-sharing system, you will have the basic tools for avoiding a mid-air collision. And as you learn to use your eyes properly, you will benefit in other ways. Remember, despite their limitations, your eyes provide you with colour, beauty, shape, motion and excitement. As you train them to spot miniscule targets in the sky, you will also learn to see many other important "little" things you may now be missing, both on the ground and in the air. If you use the brain behind the eyes, you will be around to enjoy these benefits of vision for a long time.

**TYPICAL GLIDER BLIND SPOTS**



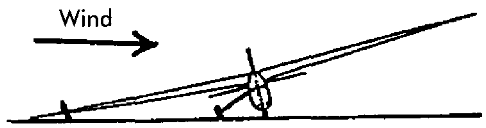
# CHAPTER 5 - OPERATING PROCEDURES

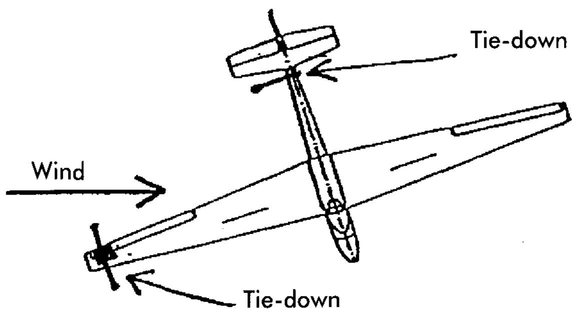
## PARKING, SECURING AND GROUND HANDLING OF GLIDERS.

One of the many differences between gliders and powered aircraft is that gliders have no means of moving around the airfield and have to be pushed or towed everywhere. Also, when they are waiting around the airfield to be launched, they need to be properly parked and secured or they could be overturned by a strong wind. There are special precautions to be observed when carrying out these duties, to ensure that gliders are properly protected when being parked or manoeuvred on the ground.

### Parking

Conventional gliders have one mainwheel and usually a tailwheel or tailskid. Exactly how a glider is parked and secured depends on whether it is being left for a short time (a lunch-break, for example) or whether it is being tied down overnight.



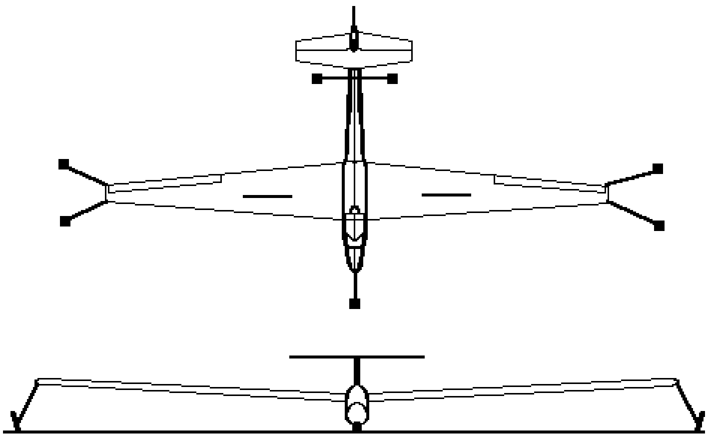

To park and secure a glider for a short period, the best way to do it is as illustrated below.

The glider is parked with its wings across the wind, with the into-wind wing placed on the ground. Note that the wind does not blow exactly parallel to the wing - the glider is positioned in such a way that the wind blows partly onto the trailing edge. This means that no lift can be developed by the wing, because the airflow is the wrong way, from trailing edge to leading edge. The wing is firmly secured by hammering in two pegs, one in front of the leading edge and one behind the trailing edge. A cushion is placed on top of the wing and a rope is stretched between the two pegs, over the cushion. This prevents the wing from being lifted by the wind. Another peg is driven into the ground on the "upwind" side of the rear of the glider and a rope is passed around the rear fuselage and secured to the peg. This prevents the tail of the glider from swinging or "weathercocking". The glider is now secure in quite strong winds.

If a glider is only parked temporarily, for example while another pilot gets ready, it is parked in the same way but a tyre or similar weight can be used to secure the wing, instead of tying it down. This method is not suitable for parking a glider if the wind exceeds 10 knots, and the crew should remain close to the glider if it is parked in this way over a lunch break.

The basic rule to remember when parking gliders is that they should be parked in such a way that the wing should not be able to produce any lift. Although this is not always possible over long periods, it is easy to do over short periods and should always be kept in mind.

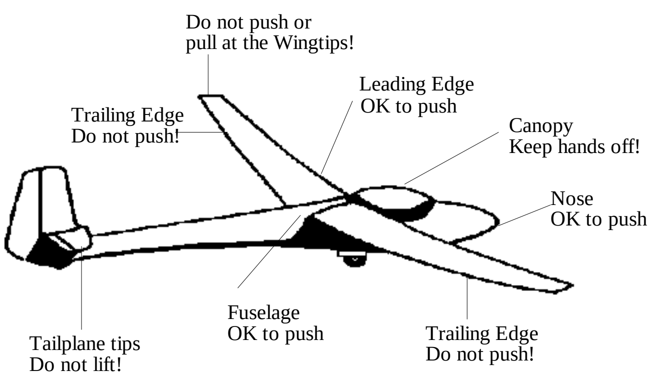
If a glider is to be parked more permanently, perhaps overnight in conditions where it is not certain which direction the wind will come from, it is usually parked with its wings level, tied to ropes which are attached to pegs driven into the ground just outside of the wingtips. This ensures that, if one of the ropes breaks or the knot becomes undone, the wingtip does not get damaged by falling onto a steel peg. It is normal to have two pegs at each tip, with separate ropes, to keep problems of this kind to a minimum.



The tail is lifted up onto a suitable support (log, large rock or a 20 litre oil-can, for example) and secured to a peg each side of the rear fuselage. The reason for lifting the tail is to reduce the angle of attack of the wing and prevent lift from being developed, in the event that the wind shifts during the night to blow onto the leading edge of the wing. To complete the job, a rope is led from a peg in front of the glider to the tow-release in the nose and securely tied. Such a tie-down job will withstand very strong winds.

## Pushing and pulling

Although gliders are very strong in flight, they can be easily damaged on the ground by handling or pushing in the wrong places. For example, leading edges of wings are very strong and can be pushed without risk of damage, but trailing edges are much weaker and must not be pushed or lifted. The following illustration shows quite clearly the parts of a glider which may and may not be handled. There may be minor variations to the illustration, but it may be regarded as typical of most gliders which are in use by gliding clubs around Australia. Anyone who sticks to the recommendations above will not go far wrong in giving someone a hand to move a glider around the airfield.



**Towing with a vehicle.**

To make it easier to transport gliders from one end of the airfield to the other, it is very common to tow them with a car or tractor. There are two ways of doing this: -

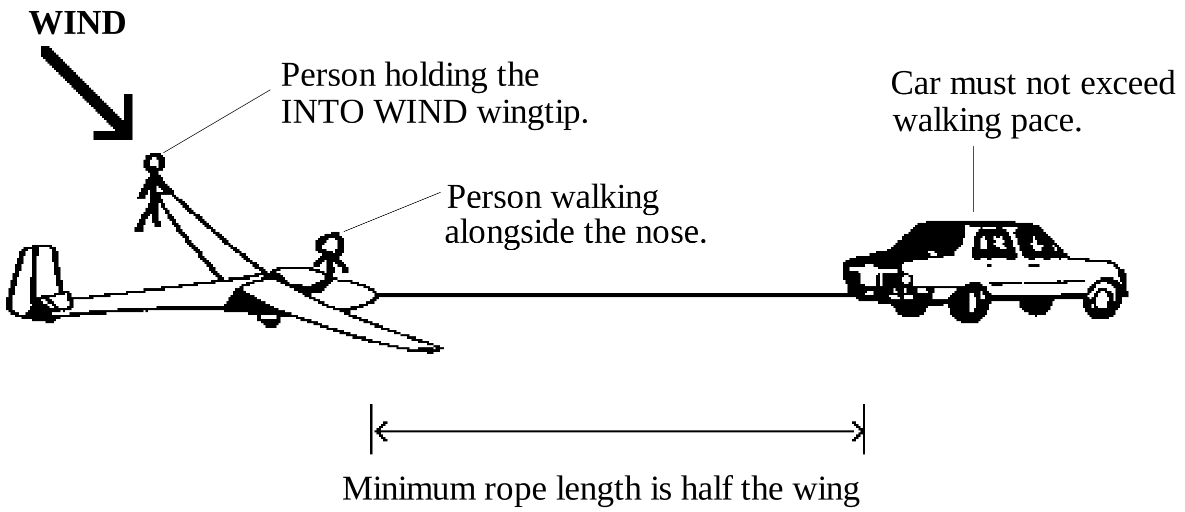
The glider can be towed in a forward direction using a length of rope attached to one of the towhooks.

The glider can be towed backwards using a rigid bar attached to a point at the tail end.

Both these methods are in common use in Australian gliding clubs. Each one needs to be done in a certain way if the glider is to be towed in complete safety. The methods will now be covered in more detail.

**Towing with a rope**

The minimum number of crew members for this method is three. Obviously there needs to be a driver, who needs to be qualified and competent. A wingtip holder is necessary and it is usual to have a third person walking by the nose of the glider to pull the release knob and release the rope if something should go wrong. Sometimes the third person is positioned at the tail of the glider, to lift the tail clear of the ground and avoid too much wear on the tailskid. See illustration.




When towing a glider by this method, the following points should be noted:-

The minimum rope length must be at least half a wingspan. This is because, if the glider starts to overtake the car (a downhill slope, for example), the person on the wingtip can hold back on the tip to swing the glider clear. If the rope is too short, a collision with the car could occur. If the rope is long enough to keep the glider clear of the car, the idea is obviously a good one.

If towing in a crosswind, the into-wind wing must be held. The reason for this is simply to prevent the wind getting under the wing and making it difficult or impossible to hold.

The flying controls should be held secure by tying them securely with the seat-harness. This is because, if the glider is towed with a strong wind behind it, the controls "gybe" like a dinghy sail and they can be damaged.

The glider should be towed at no more than walking pace. The driver should choose the speed according to the shortest person in the crew, so as not to wear his/her legs out!

A car towing a glider should have the driver's window down and the radio off. This is to make it easier to hear a warning from the crew (Stop, slow down, etc).

**Towing with a rigid bar**

This is not very common with training gliders but is quite normal with high-performance sailplanes. The rigid bar is attached to the car's towbar and such a system is often used in combination with a "clip-on" wheel attached to one wingtip. By this method a glider may be towed around the airfield with no crew other than the driver. The main rule to be observed by a driver using this method is that the glider must never be towed at faster than walking pace, in spite of a temptation to go faster because of the lack of a crew to worry about.

Another thing to be remembered by a driver towing a glider on a rigid bar is that it is easy to forget that the glider is on the back. The results of trying to fit a 15 metre wingspan glider through a 14 metre gap can be imagined. It has happened.

As with everything else in the sport of gliding, the ever-present rule is SAFETY FIRST. It is such a pity to observe all the safety rules in the air and then forget them on the ground. The average for gliders being blown over and written off in Australia is one per year. Every one of them could have been avoided by learning and remembering the basic ground-handling rules laid down here

# LAUNCHING

A basic description of each launch method appears in Chapter 1. At this point we will cover the launch-point equipment, safety precautions and signals for each of the methods, followed by a basic discourse on handling techniques and emergencies.

## Winch launching

At the end of the length of wire which is drawn out from the winch, there are certain items of equipment which play a part in the safe launching of the glider. A typical make-up of a cable-end is as follows -

1. The cable itself. Although traditionally known as "cable", the material commonly used (and recommended by the GFA) is "Range 2 spring steel wire" of either 2.8 mm or 3.15 mm diameter. This is the wire used to make bedsprings and is readily available from spring manufacturers in 300 kg rolls. Exceptionally, wire rope of 3 mm or 4mm diameter may be used, but only where fairly soft grass surfaces are available for launching, as wire rope is both expensive and susceptible to failure by abrasion and ingress of dust.

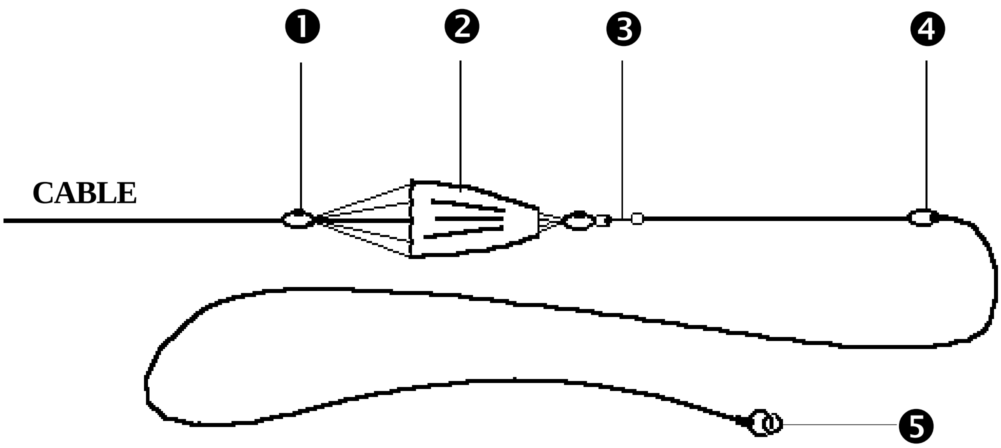
2. Swivel. This is used for taking out any spinning tendency imparted to the cable by the drogue. It is optional for spring wire, but essential for wire rope.

3. Drogue parachute. Usually about 1.5 metres in diameter, the drogue is used to stabilise the wire after release and keep it under some tension. Some clubs using stranded cable instead of the more usual solid wire do not use a drogue. However, such clubs are in the minority.

4. Weak link. This vital piece of equipment is fitted to protect the structure of the glider from damage due to overspeeding of the launch or the pilot trying to climb too steeply. The correct weak link must never be omitted.

5. Trace. This length of rope or stranded wire acts as a shock absorber for the launch and serves as a spacer to keep the drogue at a suitable distance from the glider. The minimum length for a trace is 5 metres.

6. Release rings. This is a linked pair of rings of standard "Tost" design. The smaller ring is inserted into the winch-release hook of all gliders. Two rings are used, rather than just one, in order to ensure that the force exerted on the glider towhook is a straight pull, no matter what the angle is on the cable itself.



A cable is never attached to a glider unless the pilot specifically requests it. The appropriate ring is inserted into the glider's towhook, the "belly" hook being used for winch launching, the pilot opening the hook to facilitate this. The hook's ability to release under some tension is required to be checked before the first flight of each day.

Belly-hooks are required to have an automatic over-ride or "back-release" mechanism fitted. This protects the glider in the event of failure to release when the pilot pulls the yellow handle. It does so by sensing the downward force on the hook and opening a back-releasing "cage" when an angle of just over 75 degrees to the horizontal is achieved. It is checked before the first flight of each day, by pulling VERTICALLY downwards under considerable tension. Checking a back-release by pulling the cable back towards the tail of the glider is really not searching enough and such mechanisms should not be checked in this way. However, vertical pulls are not always possible on gliders with minimal ground-clearance. All you can do in this case is get the pull as vertical as you can.

As an absolute last resort, winches are equipped with a means of cutting a cable, should it fail to release from the glider for any reason. With the reliability of modern tow-hooks and present day maintenance practices, such action has not proved necessary for many years.

### Auto-towing

For auto (motor-car) towing, everything is the same as for winch-launching, except that some autotow operators use polypropylene or polyethylene rope instead of wire. Parafil rope is another, although expensive, alternative method for autotowing. Such ropes may be used without a drogue or a swivel, although the rest of the equipment will still be necessary.

As a precaution against the unlikely case of release failure in the glider, the tow-car is required to have a means of releasing the cable.

### Aero-towing

The attachment to the glider is the same in principle as for winch and auto-towing, but two points should be kept in mind.

> Many gliders (probably most gliders) have a nose-mounted hook specifically for aerotowing. This hook should always be used in preference to a belly hook.
>
> Some operators have a preference for using the larger of the two rings for attachment to the aerotow hook of the L13 Blanik glider. Check with your club for specific advice on this point.

The weak link on an aerotow rope is normally fitted at the tug end. This protects the glider against overstress on tow and also protects the tug in the event of the rope getting fouled in a tree or power line on the landing approach.

However, some gliders of very light weight (e.g. Kingfisher) need a weak link significantly weaker than that needed by most tugs. In this case an additional weak link appropriate to the glider weight will need to be inserted at the glider end.

## LAUNCHING SIGNALS

When a glider is ready to launch, there must be a system of easily-understood signals between pilot, via the ground crew, to the launching machine, whether it be a winch, car or aircraft.

Before giving any signal, the pilot must check "all clear above and behind". He does this with the assistance of the person outside the cockpit, who is able to see into the areas outside of the pilot's field of vision. The outside person responds to the pilot as appropriate - "all clear above and behind" or, for example "no, hold, aircraft on final approach". This is the final safety check before launching and is NEVER omitted. The glider's wing is not lifted until the all-clear signal is given.

From the pilot's point of view, the signals are exactly the same whichever launch method is in use. There are three signals which the pilot may initiate, and those signals are as follows:-

**Take up slack -** this is where the slack in the launching rope or wire is taken up until it is tight.

**All out -** this means that all the slack is out of the rope or wire and the driver or pilot may apply whatever power is necessary to get the glider off the ground. (Note - some parts of Australia use the expression "Full power" instead of "All out").

Before going on to the third signal, it is important to realise that the only person who can cause a launch to begin is the pilot. Nobody else is allowed to give those signals unless that person is known to be relaying directly from the pilot to the signaller.

The third signal is the most important of all and must be clearly understood by everyone in the vicinity of a glider being launched. It is the **STOP** signal. Its purpose is obvious - to stop the launch from taking place. There may be a number of reasons for doing this; for example someone may notice that the pilot has forgotten to lock the airbrakes or cockpit canopy, or a small child might escape from the mother's clutches and run across the front of the glider being launched. When these sorts of things happen, the launch must be stopped immediately. The problem is that the pilot might not realise that there is something wrong. For this reason the general rule is that ANYONE at the launch point may give a stop signal if that person sees something dangerous happening or about to happen.

In signalling, as in all other things around a gliding operation, the basic rule is SAFETY FIRST. No person should ever be afraid of shouting "Stop" if it appears that something is not quite right. Nobody minds if the person was wrong in his judgement - the launch can always wait until everything is checked, but it is most important that nobody gets hurt.

Now the signals themselves.

## Aerotowing

In this method of launching, the distance between the glider and the towing aircraft is not great and in most cases the pilots of both aircraft can see each other. In spite of this we will ensure that we give clear signals to the tug-pilot so as to avoid confusion and keep the operation completely safe. As stated previously, all launch signals (apart from "Stop") originate from the pilot and no signals can be given unless the pilot has authorised them. So we will assume the pilot has checked that all is clear for take-off and authority has been given to the wingtip holder to give the "take up slack" signal. The wingtip holder waves one arm to and fro in an underarm motion and keeps doing it while the slack is being taken up.

This signal is relayed to another signaller standing forward and to one side of the tug aircraft. This signaller, who is easily visible from the cockpit of the tug, repeats the take up slack signal and the tug moves slowly forward to tighten the rope.

When the rope is tight the wingtip signaller gives the "all out" signal, which is an over arm wave.

This signal is also relayed to the tug pilot by the forward signaller and tug pilot applies power to the engine to continue the take-off.

If the launch needs to be stopped for any reason, the wingtip holder shouts "Stop", puts the wingtip down on the ground and raises both arms above the head. When the pilot hears the word "Stop" being shouted, he immediately pulls the release knob to release the rope. Meanwhile the forward signaller repeats the stop signal by raising both arms above his head and the tug pilot stops the take-off. It is obvious that the pilot needs the left hand to be near the release knob during the take-off, so hand signals from the cockpit should not be used, as they are a major distraction.

Note: Some clubs choose to dispense with a forward signaller. This is an unsatisfactory practice because, if a stop signal is given just after the launch has started, it will not get to the tug pilot. No pilot looks backwards on a takeoff and in some tugs it is impossible to see behind in any case.

### Winch and auto-launching

This differs in the important respect that the distance between the glider and the launching device is much greater than with aerotowing. This necessitates a positive long-distance signalling system which is free of any interpretive problems.

The signals from the pilot to the outside person are the same as for aerotowing. The message can then be conveyed to the winch or towcar by either visual or audible means. Visible signals can be either bat or light and audible signals can be either telephone or radio.

If a bat is used, the signals are exactly the same as for aerotowing. An underarm wave of the bat is "take up slack", an over arm wave is "all out". The "stop" signal consists of holding the bat steady over the head. The bat is large enough to be seen at a distance of well over a kilometre and is usually painted an easily-seen colour such as white or fluorescent orange.

If lights are used, the traditional system is that morse dashes mean "take up slack", dots mean "all out". "Stop" is a steady light. Variations on this system are sometimes used in hot, arid areas of Australia, where the summer "mirage" effect obscures the detail of such signals. Clubs in these areas have devised alternative light signals which suit their requirements and appear to work successfully.

A field telephone is sometimes used. Some such installations are permanent, often using a fence wire for the link up, with earth return.

Radios may be CBs (27Mhz or UHF), which are reasonably reliable but suffer from interference from other CB users. VHF on one of the glider frequencies is sometimes used, but these frequencies are busy at weekends and a vital part of the launching message could get blocked. If any kind of radio is used it must be external to the glider, to allow the launch to be stopped promptly if someone outside the glider sees something wrong.

As a back up, in case of failure of any of the foregoing primary signalling systems, wing waggling may be used. "Take up slack" is signalled by rocking the wings as much as the wingtip holder can manage. "All out" is signalled by holding the wings steady and level. "Stop" is putting a wing down after the pilot has released the cable.

## LAUNCH HANDLING TECHNIQUES

A student pilot should not attempt a launch of any kind until the instructor is confident that a grasp of basic handling techniques, coordination, anticipation, etc, has been attained. Applicable techniques are as follows.

### Winch/auto launching

From the pilot's point of view, these two launch methods are almost identical. The only real difference is the pace at which things happen at the start, winch launching tending to be a bit more rapid than autotowing. The launch can be taken in four sections, viz -

#### *1. Ground run and separation*

This is the stage at which the glider begins to accelerate and should be placed in the "flying attitude" by appropriate use of the controls. Gliders differ in the precise actions needed on the controls at this stage - the instructor will give the necessary guidance.

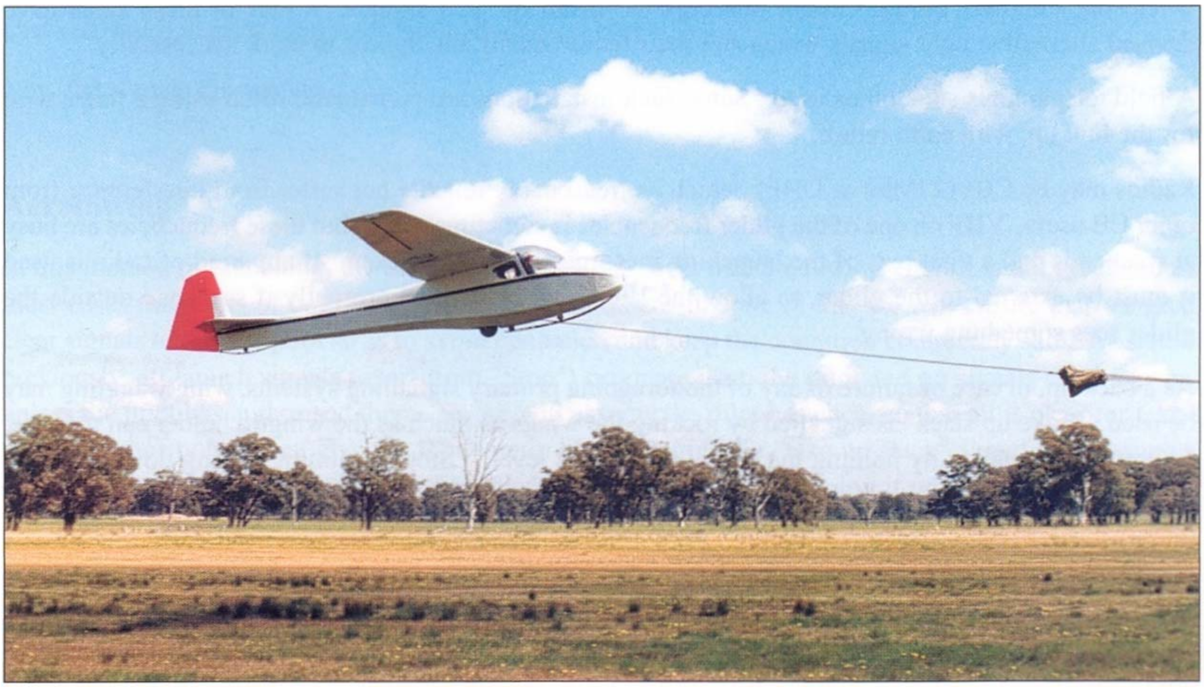
If the correct take-off attitude is not established, it is likely that the ground-run will be prolonged. It is also likely that, when it does leave the ground, the glider will leap into the air more rapidly than the pilot needs at that stage.

#### *2. Initial climb*

This is the stage at which the attitude of the glider is gently and smoothly graduated to the full climb attitude. Before allowing the glider to do this, check that the speed has risen to the minimum permitted value for commencing the climb and is still rising.

**Notes:**

1. The minimum permitted value is 1.3 times the stalling speed - 1.3Vs.
2. It is **dangerous** to climb steeply near the ground, even if the speed appears to be adequate, as it may be impossible to lower the nose to a safe attitude in the available time if a failure occurs.



*A good example of a correct initial climb. From this point on, provided adequate speed is present, the "Shortwing" Kookaburra's nose attitude will be progressively steepened into the full climb.*


*This "Bocian" is climbing too steeply for safety at this early stage of the launch. If a launch failure of any kind should occur at this point, the pilot would probably not be able to get the nose down quickly enough to regain a safe speed (it didn't happen in this case!)*

### *3. Full climb.*

A typical full climb is steep, about 40 degrees nose up. Speed must be between the minimum of 1.3VS and the maximum as displayed on the cockpit placard. This defines the "working speed band" which differs from type to type and must be known for each glider you fly. The exact degree of steepness depends on the speed; if the speed tends toward the low end of the band, ease off the climb angle a little, if it is toward the high end, it is safe to maintain a steeper angle. Climb angle is determined by glancing out at one wingtip.

There is no forward view, but direction may be maintained by glancing down each side of the instrument panel. The wings are kept level, or at an appropriate bank angle in a crosswind, by glancing to each wingtip in turn.

The maximum placarded winch/auto launch speed must not be exceeded when in full climb.

### *4. The release.*

The correct time to release is usually signified by the winch or car driver positively closing the throttle. The loss of power at the top of the launch is easily discerned by the pilot. At that point, lower the nose just below the horizon and pull the release twice. Hold the glider straight and level for a few moments to allow the speed to settle at the value you want, and re-trim.

### Locate - Identify - Operate

Since the release stage of the launch will be taught before the take-off stage, it is opportune to introduce the concept of "Locate-identify-operate" at this time. This means that any ancillary control, in this particular case the release, should not be operated until it has been positively located and identified as the one required. This eliminates any possibility of error in selection of the wrong control. The principle applies to all ancillary controls - airbrake, flaps, and undercarriage - and in the latter case extends to ensuring that the undercarriage selector is placed in the appropriate position in accordance with the placards fitted to the glider.

## Aerotowing

Aerotowing is an exercise in formation flying. The rope attached to the nose-hook of the glider is about 55 metres long. The tug pilot holds as constant an attitude as may be possible in the day's conditions and the glider pilot's task is to remain in as steady a position as possible behind the tug.

The climb rate of an aerotow combination is nothing like as high as a winch or auto launch. It may take several minutes to get to a satisfactory height to release the cable. The nose attitude is such that the horizon is in view at all times.

Like winch/auto launching, aerotowing also lends itself to being split up into a number of different stages.

### *1. Pre-take off and ground run*

The controls should be held in such a way as to get the glider into the required takeoff attitude as soon as practicable on the ground run. The trim should be set in the position which will be needed on tow - if this is not known, trim fully forward before takeoff and be prepared to re-trim during the aerotow. Ailerons are used to keep the wings level and rudder is used to keep the glider running straight along the ground behind the tug.

### *2. Separation and climb-away*

If the glider is held in the correct take-off attitude, it will separate from the ground when it has enough speed. It will lift off before the tug. When it does, it should be flown at a height of about six to ten feet up (about the height of the tug's fin). This keeps the glider above the propwash of the tug and this position is maintained until the tug also separates.

When the tug leaves the ground, a noticeable slipstream is produced from its wingtips and this combines with the propwash to produce considerable turbulence. If intending to carry out a high tow, a position above the slipstream is maintained as the combination climbs away. Remember that high tow is, by definition, just above the slipstream, not above the tug. The slipstream is the primary reference, not one of the fixtures on the tug.

**Note:** Slipstream is composed mainly of wingtip vortices. It is only present in flight, not on the ground. The only tug-produced turbulence on the ground is propwash.

If intending to carry out a low tow, maintain station above the slipstream until the tug is positively established in a climb. Then move gently but positively down through the turbulence of the slipstream until the turbulence ceases. The glider is now in the low-tow position. Once again the slipstream is the primary reference. Do not go too low in relation to the slipstream - it is not necessary.

### *3. Normal climb*

The glider maintains position directly behind the tug, in either high or low tow, during straight flight and in turns. When turning, the bank angle of the glider should match that of the tug.

It is important to trim the glider to fly "hands off" on aerotow. It considerably reduces pilot workload.

### *4. Release*

The release is carried out from the position in which the glider is being towed, i.e. if towing in low-tow, release from low tow, if towing in high tow, release from high tow.

Prior to releasing, the pilot must check that the airspace is clear to the right, where the glider is just about to turn, and to the left and below, where the tug is just about to descend. When you have checked these things, remember the Locate - Identify - Operate principle again.

The release should be operated while the rope is still under some tension, to help the tug pilot sense the glider's departure, and the pilot must note the release of the rope. It does no harm to say out loud "rope gone" as an aid to positively identifying a clean release.

Following release of the rope, the glider is turned to the right without delay and the tug begins a descending turn to the left when the tug pilot has confirmed that the glider has in fact released.

## CROSSWIND TAKE-OFFS

### Winch/auto-tow

There are two considerations when taking off on a winch or auto launch in a crosswind, viz.

*Glider on the ground*

While the glider is still on the ground, accelerating to its take-off speed, it will try to "weathercock" into the wind. The pilot should anticipate this and start the take-off run with "downwind" rudder applied. Although there should be no inherent tendency to drop a wing, the into-wind wing should be held down a little to prevent the wind getting under it. This means that, when the glider is on the ground, you should expect to use crossed controls to keep straight until separation.

*Glider in the air*

As soon as the glider separates, it will start drifting downwind. This needs corrective action by the pilot, which will consist of turning the nose of the glider slightly into the wind and leaving on a small residual amount of bank to hold the correction. You will usually need a small amount of rudder in the same direction as the bank, to make it work properly. The whole launch is flown like this, only reverting to wings-level, controls-central, flight after the glider has been released from the launch and the glider is no longer tethered to the ground. The exact amount of bank and rudder to use will vary with the wind strength and direction.

### Aerotow

There are three considerations when taking off on an aerotow in a crosswind, viz.

*Both aircraft on the ground*

From the glider pilot's point of view, this is the same in principle as for a winch-auto launch, except for two things,

(i) The ground-run is more prolonged because of the lower rate of acceleration. This means the controls take longer to become effective and it may take more control application to have any result. Once again, crossed controls will be necessary to keep straight.

(ii) The spiral-pattern propeller wash from the tug drifts downwind and gets under the downwind wing of the glider, pushing it up. This results in the **into-wind** wing going down quite suddenly about three or four seconds after the start of roll. This may catch a pilot out, having probably been conditioned to expect the wind to get under the into-wind wing and cause the **downwind** wing to go down.

If the into-wind wing goes down and actually strikes the ground, it is quite likely to accentuate the weathercocking tendency and may cause a ground-loop.

*Glider airborne, tug on the ground*

When the glider separates, the controls should be uncrossed and the glider turned into-wind by the amount necessary to cancel out the drift and stay in position behind the tug. Note that the glider's heading will be noticeably different from that of the tug - this is normal.

*Both aircraft airborne*

The tug, which has been making the same corrections as the glider, will uncross its controls when airborne. The effect of this is to leave the glider displaced to one side. This is easily corrected.

## LAUNCH EMERGENCIES

A number of abnormalities, loosely termed "emergencies", are possible at any time with any launch method. They are all easily coped with by the glider pilot and none of them should cause any grey hairs.

### Winch/auto launching emergencies

"Things that can go wrong" to cause an emergency on a winch or auto launch can be split into two kinds - (a) a failure of some description or (b) any other problem which puts the launch at risk.

### (a) Launch failures.

A failure may be a cable-break or an engine failure in the winch or car. Cable-breaks are sudden; engine failures may be sudden or progressive, depending on the nature of the failure. Either can occur in the air or on the ground.

*Launch failure in the air*

Regain and maintain the safe speed near the ground (1.5Vs). This is achieved by lowering the nose quite smartly from whatever attitude it was in to the required attitude for a safe speed. Aim for the attitude normally used when approaching to land.

Operate the cable release mechanism twice

Decide where to land in view of the height available. Low level launch failure demands a landing straight ahead, as there is insufficient height available to make the required turns to land anywhere else. As the height of the failure increases, so the options for landing open up until eventually it becomes possible to complete some kind of circuit, albeit maybe a modified one (see pages 45 to 48)

In the event of a launch failure occurring at a low height, but for some reason the glider has been pulled a long way down the field, a landing straight ahead must still be made but there may be insufficient room to land inside the airfield. An off-field landing becomes inevitable.

The portion of sky where the glider is too low to manoeuvre but too high to land straight ahead on the aerodrome is known as the NON MANOEUVRING AREA (NMA). The glider should not be allowed to enter an NMA. If a launch is so sluggish at the start that entry into the NMA seems likely, do not hang on and hope for the best - release and land ahead on the aerodrome while you still can. This is imperative on those aerodromes where an off-field landing is hazardous because of trees, rocks, or other obstacles.

*Launch failure on the ground*

This entails pulling the release to get rid of the cable and then keeping the glider under control until it slows to a stop. Because of the possibility of an emergency on the launch the left hand must be kept near the release knob at all times during every launch.

**(b) Other problems.**

Again these can be split into problems in the air and problems on the ground.

*Problems in the air*

Winch or car driver selects too low a launch speed. If the speed falls below the optimum but has still not fallen to the minimum of 1.3Vs, a "too slow" signal may be given to the driver. This signal consists of lowering the glider's nose and rocking the wings by coordinated use of ailerons and rudder. If there is no response and the speed continues to fall, continue lowering the nose to the approach attitude and RELEASE. Subsequent actions consist of acquiring and maintaining at least 1.5Vs and choosing a landing plan in accordance with (iii) of "Launch failures."

Winch or car driver selects too high a launch speed. If the speed is showing an upward trend but has still not reached the placarded maximum, a "too fast" signal may be given. This consists of yawing the glider from side to side, taking care not to allow secondary effect of rudder to produce any roll which may confuse the driver. Do not lower the nose prior to giving this signal. If there is no response and the speed continues to rise, RELEASE IMMEDIATELY. Then again follow the actions outlined in (iii) of launch failures.

Failure of glider to release. Thanks to virtually foolproof hook design and greatly improved maintenance of these devices, release failure is extremely unlikely. It should occur, fly straight ahead after pulling the release to allow the automatic back releasing mechanism to operate. If this still does not do the trick, you have exhausted all the options which are under the pilot's control and you are now at the mercy of the winch or car driver, who will jettison or cut the cable at his end. The glider must then be flown in continuous descending circles within the aerodrome, straightening out at the last reasonable moment and landing ahead with goodness knows how much cable still attached. There is not much experience in Australia at carrying out this sort of thing. Those who have found it necessary to apply the above techniques in years gone by have succeeded.

*Problems on the ground*

The worst of these occurs when the glider overruns the cable at the start of the takeoff. This is usually caused by faulty winch or car driving. If this occurs, the pilot should pull the release twice and shout "stop". If it is known or suspected that the cable has fouled the wheel or skid assembly and that the launch is taking place despite the release being pulled twice, take all possible action to ensure that the glider does not leave the ground. Apply full forward stick and open the airbrakes.

DO NOT ALLOW THE GLIDER TO FLY

## Aerotow launching emergencies

**(i) Rope break.** Although generally more reliable than winch wire, aerotow ropes can still break. They usually fail at a worn knot or splice, although of course a weak link can (and should) break in an overstress situation.

When a rope break occurs, the first priority is to acquire and maintain the safe speed near the ground, 1.5Vs. This is easier to do than with a winch/auto emergency because on aerotow the nose attitude is closer to that of normal flight. Nevertheless the glider will lose speed if attention is not paid to adopting the appropriate attitude for safe speed.

The release must be operated to get rid of the remaining piece of rope. This is a controversial point and many pilots believe that it is better to retain the rope and land with it attached, rather than drop it in someone's backyard. On balance, though, it is better to get rid of it, mainly because it is one less thing to worry about when manoeuvring for a landing over an obstacle-strewn area following a low-level break. The prospect of a rope catching in a tree or powerline on late finals is not attractive, bearing in mind that most aerotow hooks do not have a back-release.

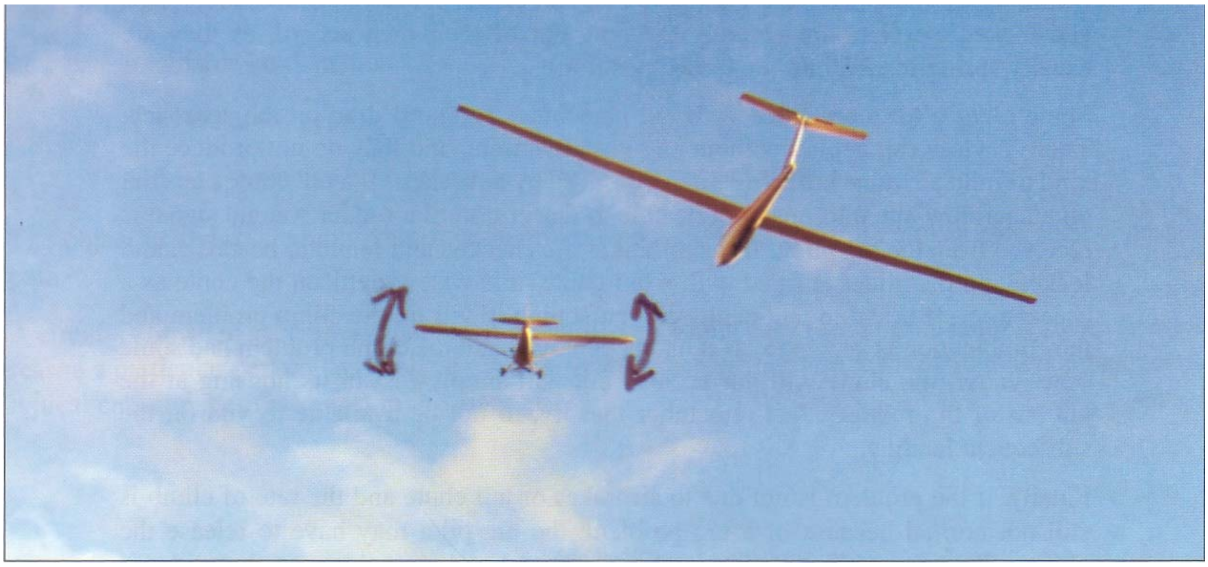
Because the climb rate of a tug/glider combination is not as rapid as a winch or car launch, there is often a "non-manoeuvring area" on every launch. A low powered tug with a heavy glider on the back may cross the upwind fence at only a hundred feet or so and the aerodrome may be unavailable as a landing area for a period as long as a minute. In this case, an outlanding in the early stages is inevitable in the event of a rope break and the pilot should become accustomed to spying out the land ahead of the glider on every launch, in case it becomes necessary to land on it.

As the height slowly builds up, other options become available. For example, from about 300ft, or even a bit lower, it is possible to turn through 180 degrees and land back in the opposite direction. In this case, keep a careful eye on other traffic and remember that whatever headwind you had will now be behind you and the groundspeed on final approach will be high. Touch down early rather than late in anticipation of a long ground run.

There are other options, depending on the shape of the airstrip, the number of runways and the exact height of the rope break. Each emergency is a little different from the last and demands conscious thought and anticipation. Above all, keep the speed up, keep the glider under full control and do not get low before the final turn.

**(ii) Rapid and sudden failure of the tug aircraft.** This will necessitate instant release without warning from the tug end. Actions on the part of the glider pilot are identical in all respects to (i) above.

**(iii) Progressive failure of the tug.** In this category are things like rising oil temperature or falling oil pressure. There is no catastrophic failure, but if some action is not taken there might be. In this case the tug pilot will rock the wings of the tug vigorously from one side to the other. When the glider pilot sees this, the required action is to release IMMEDIATELY. This gives the tug pilot the chance to get his aircraft on the ground without delay. **Note:** Any delay in releasing on the part of the glider pilot will leave the tug pilot with no alternative but to release the glider from his end. Such action is quite justifiable under the circumstances.



*Tug pilot rocks wings. Release immediately.*

**(iv) Failure of the glider release mechanism.** Although unlikely, it could still happen and a procedure is necessary to cater for it. The procedure is quite simple. If the rope fails to come off when the pilot pulls the release, try again. This often does the trick, especially as second attempts are usually a bit more determined than the first.

If it still does not release, the glider is flown out to the left side of the tug and this out-of-station position is maintained. The sideways pull on the tug's tail attracts the tug pilot's attention and he will acknowledge his acceptance of the glider's predicament by a wave of his hand. On receipt of this wave from the tug pilot, the glider is returned to the normal position behind the tug. Then, if the glider is in the low-tow position, the pilot flies it through the slipstream into the high tow position. The rope is then released from the tug end.

Two points should be noted. Firstly, it is worth trying the release again when out to the left side of the tug. A change of position sometimes moves the rings enough to make the difference. Secondly, the glider is flown to the high tow position prior to release at the tug end because it helps to ensure that the rope falls clear of the glider when it comes off the tug.

**(v) Failure of both glider and tug release mechanisms.** This is very unlikely, but a procedure is in place to cope with it if necessary. The tug descends gently with the glider in the low tow position, the glider airbrakes being deployed to keep the rope taut. The rate of descent is controlled by the tug pilot, who adjusts the power settings against the drag of the glider. The landing is made with the glider touching down first and the tug pilot allows the glider to bring the whole combination to a halt. This procedure is not essential before solo - all the other emergency procedures are. It is a useful and confidence-building post-solo exercise.

**(vi) Rate of climb not normal.** This may occur because the glider's airbrakes become open on take-off. If the rate of climb is abnormally poor and the tug pilot is satisfied that nothing is wrong with the tug (or if he sees in his mirror that the glider airbrakes are deployed) he will waggle the tug's rudder from side to side, to alert the glider pilot.

If this signal is received, the glider pilot should check that the airbrakes are closed and locked (spoilers are unlikely to come out of their own accord, as they are usually spring-loaded into the closed position).

Some older gliders are fitted with tail parachutes for extra drag on the approach. These devices can deploy without any visual warning and they do not produce the kind of mild airframe buffeting often produced by airbrakes. If a tail chute pops out on an aerotow, the pilot may not be able to detect it until a rudder waggle signal is received from the tug pilot. If the airbrakes are checked and found to be closed and locked and the glider is fitted with a tail chute, it is wise to jettison the chute as a precaution. If it had in fact deployed, jettisoning it will fix the climb problem and the combination is kept safe. If it hadn't deployed and the climb problem had some other cause, the chute will not be lost, but will simply rest in its housing at the bottom of the rudder. Just remember that it will not be available to you on the subsequent landing.

Finally, if the problem is not due to airbrakes or tail chute and the rate of climb is still not normal because of a tug problem, the tug pilot may have to release the glider. Therefore, if a rudder waggle is received and everything on the glider is checked and found satisfactory, the glider pilot should mentally prepare for the possibility of being released without warning soon afterwards.

## THE CIRCUIT PATTERN

Sooner or later we must make a decision to land the glider, either because we have had an enjoyable flight and it is time to bring the glider back for someone else to fly, or because we have run out of lift and can't stay up any longer. We must therefore consider the factors necessary for a safe landing.

For a safe landing we must have: -

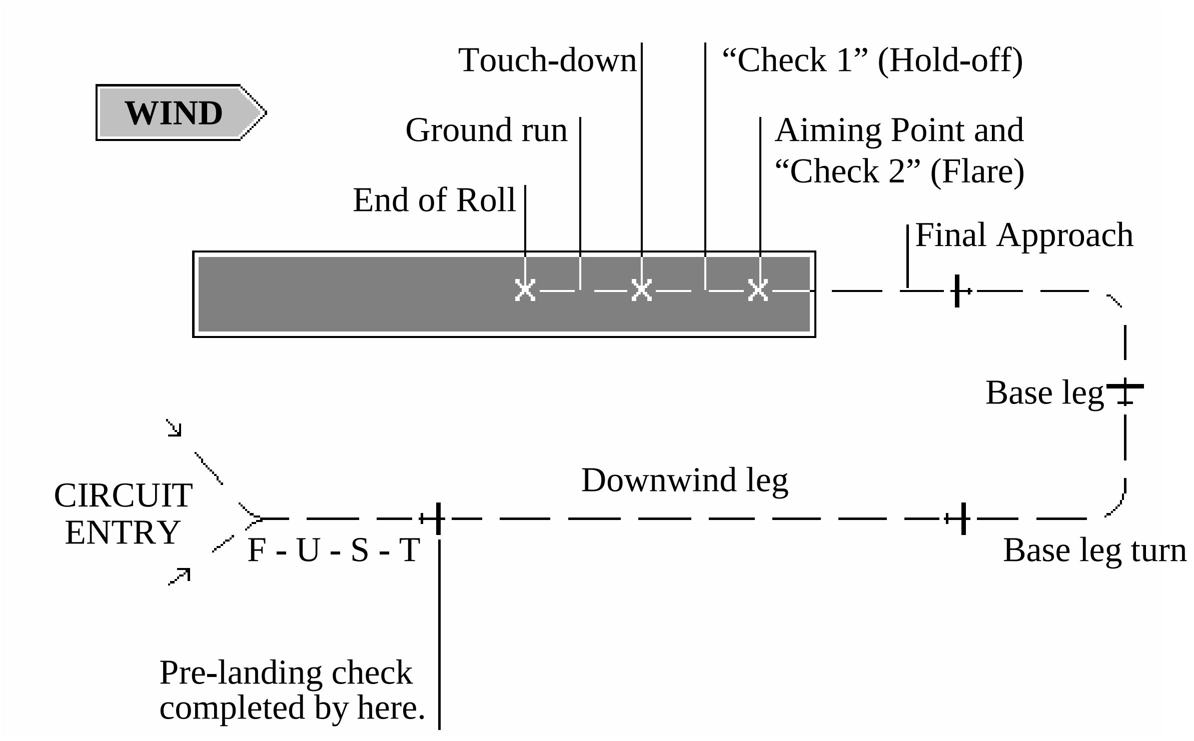
A suitable landing area

A pre-selected landing direction

A final approach path with a safe margin over obstacles.

The object of flying a circuit pattern is therefore to position the glider on a stabilised final approach path.

A circuit is flown in such a way that the glider is always within easy reach of the landing field. For this reason a particular pattern has evolved over the years which will ensure that this requirement is met. A typical circuit pattern is shown in the diagram.




There are some legal considerations in flying circuit patterns. The GFA Operational Regulations (which are subject to approval by the Civil Aviation Safety Authority) state that:

"As far as it is safe and practicable to do so, a sailplane arriving at an aerodrome shall track over the ground such that at least two turns, each of approximately 90 degrees in the circuit direction, are made prior to landing" (Op Reg 9.25).

The above Op Reg is also reproduced in the Air Legislation chapter of this manual.

The Civil Aviation Regulations also state that an aircraft must join a circuit in such a way that it conforms to circuit traffic or avoids that traffic. Gliders do not have an exemption from these requirements, unless an emergency is declared.

The pilot establishes the circuit joining area on each flight by judging the distance by which the downwind leg is displaced to one side of the landing field. This depends on the height of the glider above the ground. The glider should be flown in such a position that the downward angle from the cockpit to the runway is not too steep, resulting in too short a base leg, and not too shallow, compromising one's chances of getting to the strip if sink is encountered.

If the angle appears too steep, turn the glider away from the strip for a few seconds, then resume a track parallel to the strip and re-assess. Conversely, if the angle appears too shallow, turn in for a few seconds and resume a parallel track.

The judgement required to make these adjustments with a high degree of refinement is acquired very quickly.

Some airfields have a requirement for all circuits to be carried out in a left-hand direction, but it should be understood that a circuit may be carried out in any direction if it is necessary. However it is only reasonable that extra care be taken if going against a convention, so as to minimise disruption to other airfield users (remember also the regulatory requirements). The "extra care" should extend to a call on the radio (if carried) to announce your intentions to other airfield users.

However, having taken legalities and conventions into account, in gliders it is better to carry out a circuit in the "wrong" direction than to risk getting too low in an attempt to get to the "conventional" side of the circuit.

Carry out the pre- landing check (see check list at back of book) as early in the circuit as practicable, so as to leave as much time as possible to practise the judgement exercises.

Don't forget to check the wind direction and strength.

When passing abeam the landing area on the downwind leg (which as a matter of interest is at about 600 ft in the "average" circuit, but considerable variation is acceptable and quite safe), check the landing area is clear and pick an aiming point. This will be used on the final approach and during training it helps if it can be easily identified from circuit height. Typical examples of useful aiming points are - white runway markers or a bare patch of ground on a grass strip. Anything that attracts the eye is useful during training; later on many of the cues can be dispensed with once the principles are understood.

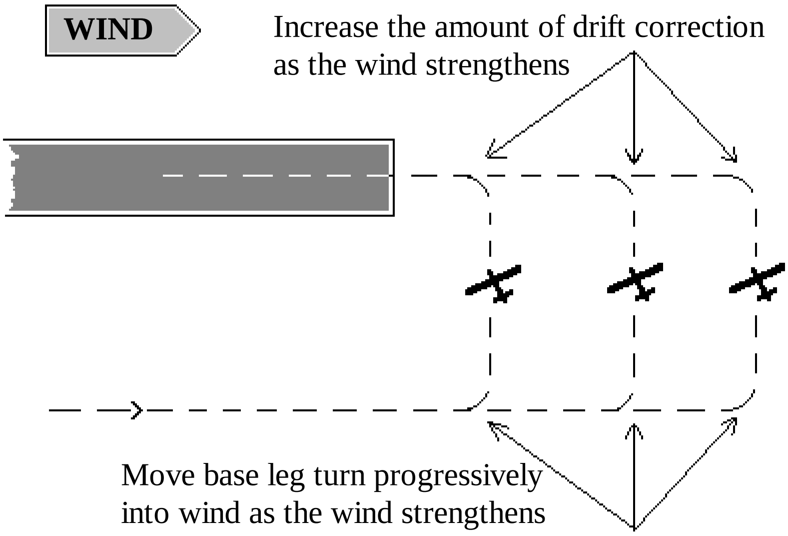
Then, in your mind's eye, draw a line, a kind of "ramp in the sky" up the approach path from the aiming point. This is the line you will follow down to the ground on the final approach. The reason you mentally sketch it all out at this point is that it helps you decide when to make the turn onto base leg.

As the downwind leg progresses and the landing area recedes behind you, glance back over your shoulder to keep that mental final approach path in view. Then, when you reach a point where a turn onto base leg will intercept the final approach path at a satisfactory height and position, make the turn.

When you have completed the turn, you should be able to see that the interception of the final approach path will take place as planned and will result in a straight run-in down the "ramp" to touch-down with plenty of time to make fine adjustments.

## Circuit variations

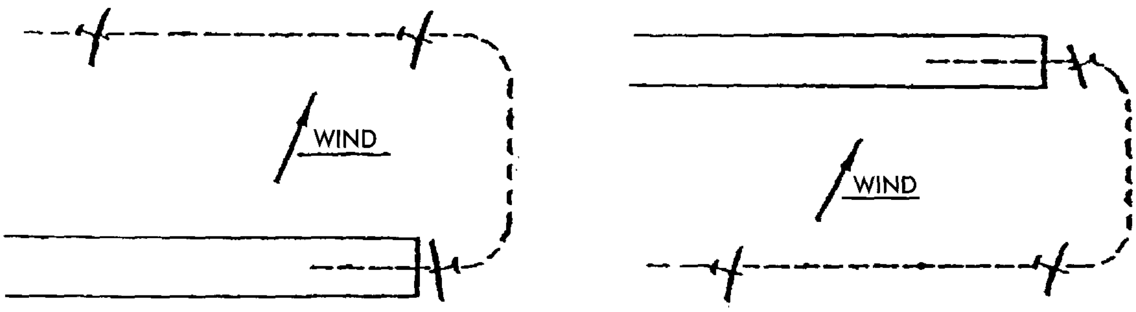
*Strong winds*




The base leg turn should be made earlier than usual in strong winds. The stronger the wind, the earlier the turn. Considerable drift correction will be needed on the base leg in strong winds.

*Cross winds*

It is preferable to do a crosswind circuit on the "downwind" side, i.e. with the wind tending to blow you away from the strip. This means that any drift correction is made TOWARDS the strip, making it easy to see the landing area. The base leg also takes a longer time to complete, resulting in a reduction in workload because of the extra time available




If compelled by aerodrome rules to do a circuit on the "upwind" side of the strip, the drift correction is made away from the strip, putting the strip to some extent behind the glider and therefore awkward to see. The base leg takes a very short time because of the high groundspeed and this tends to make for an increased workload.

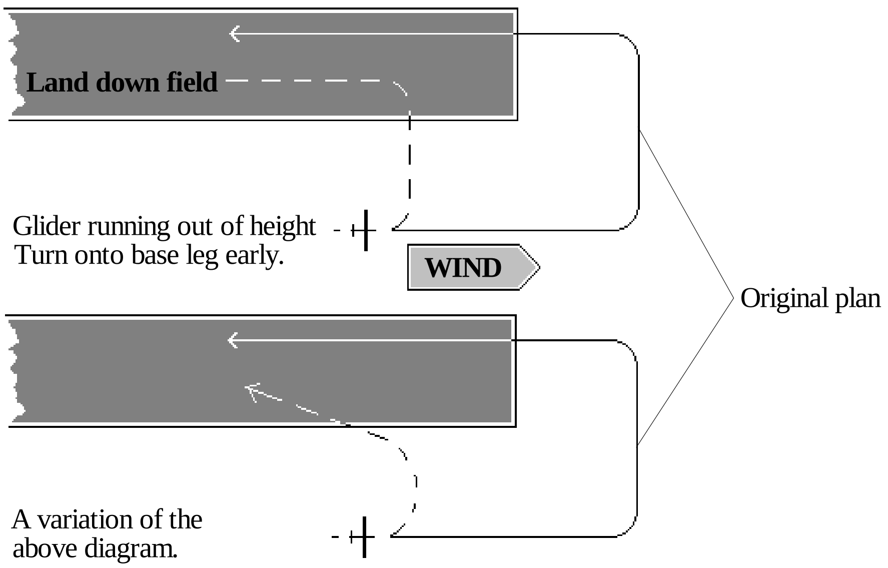
## Running out of height

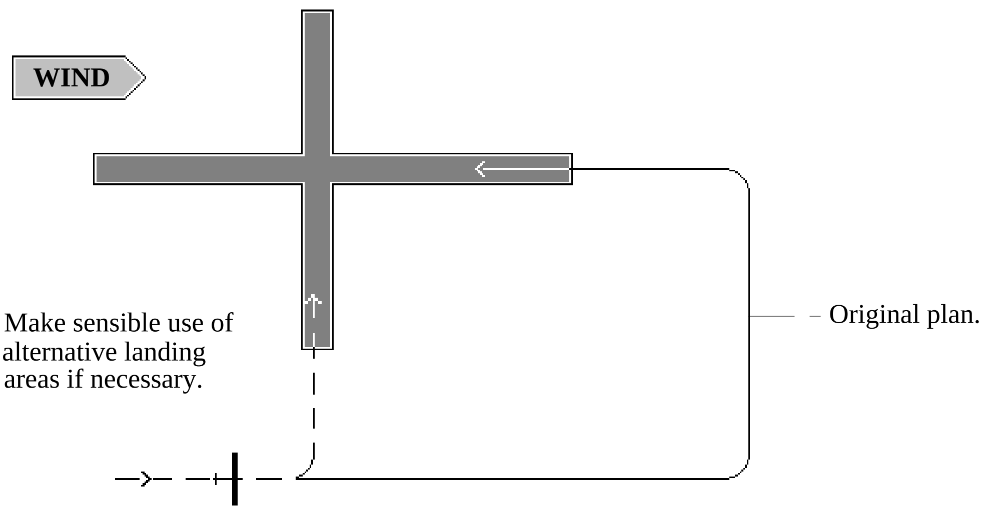
If unexpected heavy sink is encountered or a misjudgement of angle/distance relationship made, it may not be possible to complete the circuit originally planned. In this case the whole plan will need to be altered and a turn made onto the base leg much earlier, in some cases right away. A new landing area must be selected; anywhere on the aerodrome will do, the only requirement being that it is SAFE to land on. Convenience does not come into the argument. Anyone can make a misjudgement or get caught by unusual conditions; the important thing is to place safety above all other considerations. Nobody cares if the glider has to be retrieved from several hundred metres down the field.

NEVER risk a low base leg and final approach. Such a situation may be impossible to fly yourself out of, no matter how capable you are. Turn in early and land down the field. An early turn-in and down-field landing is known as a MODIFIED CIRCUIT.

**Failure to modify a circuit leaves a pilot without an escape route. This in turn increases the risk to an unacceptable level.**

## SOME EXAMPLES OF MODIFIED CIRCUITS



## What if you can't meet the legal requirements?

The examples shown deal with gliders which joined the circuit legally and in accordance with conventions and, for one reason or another, ran out of height. If a glider joins in an unconventional manner, for example flying the wrong way up the downwind leg, against the traffic stream, it creates a situation which greatly increases the potential for a collision (gliders being difficult to see head-on) and it is also illegal**.** Don't **plan** on doing it.

This raises the question, what do we do if we have been caught out by strong sink and have drifted further downwind than we intended to, thus making it impossible to get far enough into wind to enable us to join a downwind leg and fly "three legs of a circuit"? This is the kind of thing that happens to us all, and as long as we don't make a habit of it, it is no sweat. The way to do it, to minimise hazard to ourselves (by forcing a possible outlanding), and to take into account legalities and the needs of other airfield users, is as follows:-

> Position the glider as far to one side of the strip as is safe to do so, without risking being unable to get back. When you do this, if you are at an aerotow site, keep a sharp lookout for descending tugs, which may position themselves wide of the glider circuit in their return to the field. Then aim to join part-way down a downwind leg (or to put it another way, create a shortened downwind leg), prior to turning base and completing the rest of the circuit, approach and landing.
>
> Following this pattern makes you reasonably easy to see and gives you a good view of other circuit traffic to enable you to fit in smoothly and legally. If you have a radio, make a short, concise general broadcast (e.g. "All stations Temora, glider XYZ entering short downwind, left-hand, for runway 19") prior to entering your modified circuit, before your workload builds up in the circuit itself. At all times, keep a sharp lookout for other traffic. When making calls, remember that "left-hand" or "right-hand" refers to the circuit direction you intend to follow, not to the direction in which you happen to be turning at the time.
>
> If your situation is more serious (e.g. you are flying a low-performance glider and you are in very strong sink) and you are unable to make any kind of a downwind leg, you may be forced to join directly onto base-leg or even onto a straight-in final approach. If you have to do this, don't be shy, go ahead and do it, but remember you are the intruder and the onus is upon you to avoid other traffic if you cannot conform to their pattern. You may also need to explain your actions to other airfield users after the event. This isn't usually a problem, once they understand the nature of your difficulties and provided you have made every effort to do the right thing. Once again, radio is a sensible aid to safety here; it is a good idea to announce your intentions **before** you do your thing and at all times keep a sharp lookout.

Although the use of radio is strongly recommended as a useful adjunct to safety in the circuit, remember the old saying "Aviate, Navigate, Communicate". This neatly summarises the order of priorities which a pilot must remember. Don't over-concentrate on making a radio call, at the expense of losing control of your aircraft.

Although there are occasions where pilots may genuinely get caught out by unforeseen conditions or circumstances, many cases of unusual (and possibly illegal) circuits are the result of failure to think and plan ahead. There really isn't any excuse for this. Remember, a good pilot rarely, if ever, gets surprised in the air.

### Circuit illusions

When flying a circuit, it is important to pay constant attention to the glider's position with respect to the intended landing area. A common problem in circuit planning is failure on the part of the pilot to remember this basic fact.

When flying on a well-marked airfield, such as a licensed aerodrome, there are sufficient features to help a pilot to plan circuits, even if this important basic rule is forgotten. If this same pilot then flies at another field, without the familiar features to help, it comes as a bit of a shock when he or she cannot cope.

A good example is flying at an elevated airfield, where the level of the strip is different from the level of the ground which the glider covers in the circuit. The picture below, taken from the base-leg turn, illustrates the trap waiting for the unwary pilot who pays plenty of attention to the ground beneath the glider, but too little to the strip on which it is intended to land. At this particular site, there is a difference of over 300 feet between the two.

# THE APPROACH AND LANDING

## The approach

### *The base-leg*

The approach begins after the completion of the base leg turn. The glider is now about to enter an air mass which is affected by ground friction, resulting in a phenomenon known as "wind gradient". This means that the wind speed decreases progressively closer to the ground. The effect this has on the glider is to cause a decrease in airspeed at a constant approach attitude.

The reason it happens is related to the inertia of the glider and the fact that it cannot accelerate quickly enough to keep pace with the falling wind speed. If there is any wind blowing it is normal practice to fly the glider just a little faster than the basic 1.5Vs from this point on. As a rule, add one-half the windspeed to the "safe speed near the ground" already established. As an example, a glider with a safe speed near the ground of 50kts, approaching into a 10 kt headwind, will need 55 kts from the base-leg turn onwards. If there is no wind, there will be no wind-gradient and hence no need to increase the speed beyond the basic 1.5Vs.

Locate and identify the airbrake lever at this point and keep the left hand on it from now on until the landing is complete.

Look down at the landing area and scan the "ramp" you planned beforehand. If you look like intercepting it as planned, take no further action, just maintain attitude and heading. If it looks like you are a bit high (the angle looks steep and the final approach path also too steep), alter the glider's heading to move away from the strip and lengthen the approach path. If the opposite appears to be the case (everything looks a bit shallow), move in towards the strip and shorten the final approach path.

### *The final approach*

Just before you reach the line of the final approach, start the final turn. A turn of 30 degrees bank at 55 kts has a radius of about 150 metres, so you will need to anticipate this when coming out of the turn onto the precise line of the landing approach.

Get the glider lined up on final approach and say to yourself -

> Direction (is it going in the right direction? - if not, fix it).
>
> Speed (is the speed correct? Fix as appropriate).
>
> Rate of descent. This is the interesting one, because it involves the airbrakes. Use them like this -

If direction and speed are satisfactory, look over the nose at the aiming point and watch what happens to it. As the glider flies towards the landing area, losing height only very slowly at 55 kts, it will begin to overshoot the aiming point. That means, with the airbrakes in at 55kts, the glider would fly right over the aiming point and come to earth somewhere about half way down the airfield. You will soon acquire the ability to judge this important point.

Once you have identified that the glider is in an overshoot situation, this means you are guaranteed to be able to safely get into the aerodrome, but not necessarily near the point you wish to go. We can now use the airbrakes to refine the overshoot into a precise final approach path which will bring us to a landing near the chosen spot. When the airbrakes are opened, lower the nose to maintain a constant speed. The aiming point will move upward a little in the canopy ahead of you as the nose is lowered with the airbrakes out, then it will stabilise.

Keep monitoring the aiming point in the canopy ahead of you. If it once more moves down toward the top of the instrument panel, you are still overshooting and will sail right over the top of it. Open the airbrakes further and lower the nose to counter the increased drag. The final approach path will now be steeper.

If the aiming point moves up in the canopy, away from the top of the instrument panel, this is an undershoot situation and must not be allowed to continue. This situation demands immediate retraction of the airbrakes and a slight raising of the nose to stop the speed building up too high. Do not re-deploy the airbrakes until a positive overshoot situation is once more established.

A glider which is established on an approach at the correct airspeed, going in the right direction at the proper rate of descent to the aiming point, is said to be on a **STABILISED APPROACH.** A stabilised approach is of great assistance in achieving a good landing.

*This glider is about midway down the final approach, with about 20 seconds to go to touchdown. It is stabilised at a steady airspeed and a constant airbrake setting. The aiming point, in this case the start of the short grey-coloured strip in the centre, is in a constant position in relation to the top of the instrument panel and is not moving up or down.*

A few tips on ensuring a safe approach are in order: -

NEVER use the airbrakes in an "automatic" fashion after the final turn is completed.

On EVERY approach, ensure an overshoot situation exists before using the airbrakes

NEVER allow an undershoot situation to persist. Retract the airbrakes immediately an undershoot is even suspected. Remember that an undershoot is at least twice as difficult to identify as an overshoot.

Stabilise the approach as soon as possible after the decision to use the airbrakes has been made.

Avoid extremes of airbrake use. Neither a full airbrake nor no-airbrake approach is satisfactory for normal purposes. About one-half airbrake gives an option either way for controlling any overshoot or undershoot which may develop.

Give yourself TIME to make the necessary adjustments during an approach. From the completion of the final turn to the start of the landing itself should not be less than 30 seconds and can with advantage be up to a minute. If you rush it, you will not get stabilised and the result will be a poor landing.

## The landing

As the glider approaches the ground, the task of the pilot is to change the glider's nose position from the approach attitude to the landing attitude. This is the process known as the "flare". The exact moment to do this and the exact amount by which it is done is a source of worry to many pilots learning to fly. Let's see if we can allay some of those fears that naturally come into play when the glider is approaching the ground.

The first thing to realise is that there is no "exact moment" or "exact amount". There is quite a margin for error in both the timing and the manipulation of the controls. Obviously there is no room for any gross errors at this stage, but no instructor will allow any pilot still prone to making gross errors to have a go at a landing anyway.

*"Check 1"*

As the glider approaches the ground, when it is apparent from the cockpit that the aiming point is being achieved and the ground is getting close, transfer the eyes to look further up the field. When you have done this, raise the nose of the glider very gently towards the horizon. Stop the nose-up movement just before it gets to the horizon. This raising of the nose and stopping the movement at the appropriate point is called "Check 1" and the glider is now said to be "flared".

This is the first stage of the landing and its purpose is to change from the approach attitude to something fairly close to the landing attitude. When this stage is complete, the glider will be flying level about 2 or 3 feet off the ground, decelerating rapidly under the influence of the deployed airbrakes.

*"Check 2"*

There will now be a natural tendency for the glider to gently lower its nose as the speed decays. The pilot resists this by resuming the back movement of the stick to keep a fairly constant nose attitude. This action is known as "Check 2", or sometimes as "holding off". The backward movement of the stick is continued until the glider eventually sinks onto the ground, touching its mainwheel and tailwheel/skid more or less simultaneously.

Once on the ground, the stick is held back, the airbrakes are opened fully and the wheel-brake (if fitted) is used if considered necessary. The glider is kept straight with the rudder and the wings are kept level with the ailerons.

*The pilot of this Kookaburra has just carried out "Check 1" (levelling the glider off, or "flaring" it), and is just starting "Check 2" to keep the glider flying at about 3 feet above the ground until it touches down at minimum speed.*

## Some tips for good landings

When learning, start "Check 1" early rather than late and make it a gradual and gentle movement. The worst situation for both instructor and trainee is the late, sharp Check 1. If you do it too early it doesn't matter very much because there is time to fix it.

If all appears to be going according to plan, do not fiddle with the airbrakes during Check 1.

The object is to "fly off" residual speed during "Check 2", resulting in a touchdown at minimum speed on two points. It is NOT a "stalled-on" landing - such a thing is impossible to achieve in a glider.

Do not be tempted to look at the airspeed indicator when you are getting close to the ground. You need all your attention on the external visual cues for judging Check 1 and Check 2 properly.

If there is any wind blowing, there will be a wind gradient. This means that you can expect a fall-off in airspeed when the glider gets near the ground. If you sense this happening through sound and feel, don't worry about it, it is quite normal. Do NOT push the stick forward to try to speed up at this stage.

## Errors in landings

There are several common errors which are made by pilots in the early stages of learning to land a glider. They are divided almost equally between errors of judgement and those related to wrong manipulation of the controls. The errors and their solutions can be summarised as follows.

*Looking too close to the glider when approaching the ground*

This is a judgemental error and was covered in the preceding paragraphs. Failure to transfer the eyes away from the aiming point is a major contributor to difficulty in judging the glider's height above the ground and is the single biggest factor in late "Check 1s" and their consequent heavy landings. A pilot who continues to stare at the aiming point when the glider is at a very late stage of the approach will almost certainly hit it hard, at undiminished rate of descent. An instructor faced with the probability of a late Check 1 will almost invariably take over from the trainee and land the glider. There are ample grounds for such a takeover.

*Check 1 too early*

Another judgemental error, this one is not as serious as leaving it too late, because there is time to fix the problem by stopping whatever backward movement has been applied to the stick. Most instructors will talk a trainee through this error and it is very soon fixed.

*Insufficient back movement on the stick*

This is an error in control manipulation. The amount of back movement required on the stick to achieve Check 1 varies greatly from type to type. It also varies to some extent with airspeed and airbrake setting. If very little movement is used, the glider will hardly raise its nose at all and will arrive heavily on the ground. In some cases it may arrive very heavily indeed and both glider and pilot(s) may suffer damage. Like the late Check 1, an instructor will usually take over if he feels such an error has been made, in the interests of a safe arrival. The obvious cure for this problem is more back movement on the stick when the glider gets near the ground.

*Too much back movement on the stick*

Another manipulative error, this one will usually cause the glider to raise its nose too much during Check 1. In turn, this results in the glider flying away from the ground, gaining height and losing speed. This is known as "ballooning". The cure is to (a) stop the back movement and (b) retract the airbrakes or spoilers to enable the wing to keep the glider flying for long enough to sort the problem out and attempt another landing. It may then be necessary to lower the nose VERY SLIGHTLY before attempting another, very gentle Check 1, but beware of excessive forward movement of the stick at this stage. In most cases the instructor will assist in the exact control movements required.

*Continuous backward movement of the stick without a pause*

This is an interesting one and is probably the most common difficulty when learning landings. When the stick comes back in order to initiate Check 1, it must only come back so far and then it must stop. If the stick movement is not checked, the problem becomes the "ballooning" problem of 4. above. The fix is also the same. There is a definite pause between the initial back movement (Check 1) and the resumption of back movement (Check 2) during the "hold-off". Refer back to the preceding section on the landing and re-read paragraphs 3 and 4. Alternatively, ask your instructor to explain the terms "Check 1" and "Check 2" in more detail.

Some or all of the foregoing errors are made by almost all pilots learning to fly gliders. They are really no different from the ordinary errors made by every pilot in the very early stages of learning to fly, errors which are made at some considerable height. The difference is that landing errors are made very close to the ground, which obviously makes them more critical and certainly puts the pilot under more stress than would otherwise be the case. For this reason, the instructor will not allow such errors to persist and will take control of the glider early rather than late if circumstances demand it.

### Final comment on circuits, approaches and landings

The foregoing information on how to plan the circuit pattern to achieve consistent good landings is intended to be used in a flexible manner. In reality, a fairly wide range of heights and positions around the circuit may prove to be quite successful in achieving a good end result. Circuit variations are essential during training in order to build-in this flexibility and to avoid breeding a pilot who goes to pieces if forced to do something different to which he or she is accustomed.

Post-solo training is invaluable for this purpose and the B Certificate is designed to ensure that a developing pilot is trained in a number of circuit variations, many or all of them to be flown without recourse to instrument indications. Note that this is NOT intended to condone the practice of unnecessarily low circuits, but certainly is intended to ensure that the pilot does not suffer from a severely degraded performance if forced to fly a little lower than normal. Otherwise, pilots will never cope with cable or rope breaks at critical heights on sites which may be surrounded by trees or other immovable obstructions.

### Outlandings

All the techniques and procedures outlined in this section on the circuit, approach and landing work equally well whether it is intended to land on the home airfield or in a paddock after a cross-country flight. The basic principles are the same in each case and a pilot who develops good judgement on the home field is unlikely to have a problem in an outlanding.

However, since the outlanding involves an arrival into a paddock of unknown quality, the following basic checklist is used to minimise the risk.

- S Size. Adequate length for landing, corner to corner if necessary.

- S Slope. If a slope can be detected from circuit height, it is too steep to land in. Pick another paddock.

- S Surface. As smooth as possible.

- S Stock. Be careful with animals. Sheep are usually not much of a problem. Cows eat gliders. Horses may panic.

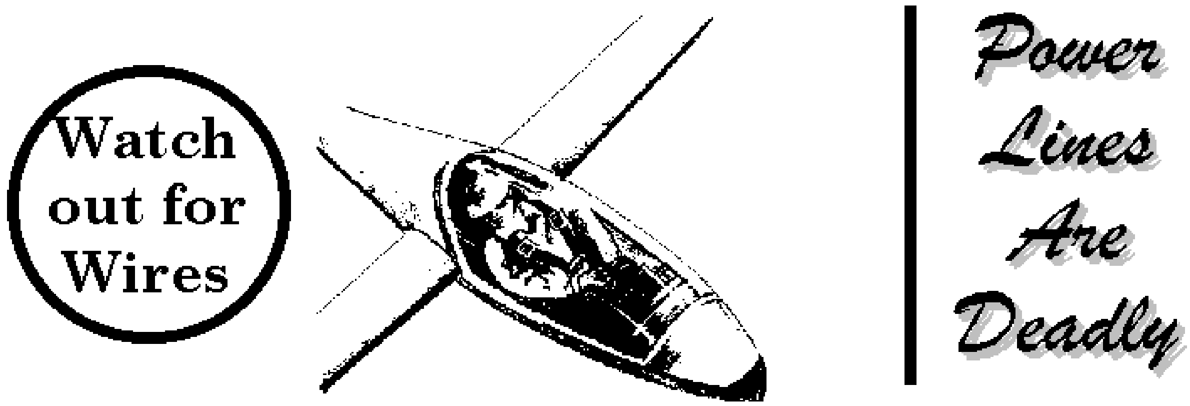
- S Surroundings. Adequate approach paths. Check particularly for POWER LINES, especially the hard-to-see SWER (Single wire earth return lines).

To enable this check to be done adequately - pick a general area for outlanding at 2000ft AGL; by 1500 AGL a specific paddock should have been selected in that area and by 1000ft AGL you should be committed to planning a circuit and landing into that paddock.

## General warning on outlandings

Because of the number of unknown or uncertain factors, any outlanding is inevitably more hazardous than a landing back at home base. The guidelines for heights AGL given above are based on the need to check all possible hazards very carefully. Adherence to the guidelines will provide adequate time to carry out this essential work.

Leaving an outlanding decision too late, at too low a height above ground, eats into the available time and eventually shuts off all the pilot's escape routes. This often has fatal results.



# CHAPTER 5 - SELF-TEST QUESTIONNAIRE

Which wingtip is held when pushing or towing a glider?

What is the minimum rope length for towing a glider with a car?

Is the trailing edge of the wing a suitable place to push a glider?

Why are two rings fitted to the end of a winch/auto wire or aerotow rope?

Who is entitled to give a "Stop" signal at the launch point?

What clearance is required by the pilot before take-off?

What is meant by the "working speed band" on a winch/auto launch?

What is the primary reference for establishing the correct towing position on aerotow?

What should be the trim position during an aerotow?

Name the sequence of events prior to and during release from aerotow.

What is the first priority following launch failure?

Define the non-manoeuvring area.

What action is taken by the pilot if the speed falls to 1.3Vs on a winch or auto launch?

What action does the glider pilot take if the tug pilot waggles the tug's rudder?

What does it mean if the tug pilot rocks the tug's wings from side to side?

What is the primary objective of flying a circuit?

What is the minimum circuit speed?

Define wind gradient. What is its effect on a glider approaching to land?

At what point on the approach are the airbrakes used?

What action does the pilot take on detecting an undershoot?

Define a "stabilised approach".

What is the recommended action in the event of the glider "ballooning" on landing?

What actions are taken by the pilot if the glider runs out of height in the circuit?

What is the final approach speed of a glider which stalls at 34 knots, approaching to land in a 10 knot headwind?

What is the minimum height above ground for selection of a specific landing paddock on a cross-country?

# CHAPTER 6 - AIR LEGISLATION

## RULES OF THE AIR

The following rules are extracted from the GFA Operational Regulations, which are approved by the Civil Aviation Safety Authority (CASA). They apply to all glider pilots.

A sailplane shall not be operated in a negligent manner or in reckless manner so as to be likely to endanger life or the property of others.

A sailplane shall not be flown in such a manner or in such circumstances as is or are likely to cause avoidable danger to any person or property (including animals) on land or water or in the air.

A sailplane shall be flown only in Visual Meteorological Conditions (VMC) at all times, in accordance with the table below. Note that, for the latter category of VMC, at or below 3,000ft or 1,000ft above terrain, carriage of radio is mandatory.

| Height | Required flight visibility | Horizontal and vertical distance to be maintained from cloud | Additional conditions |
|---|---|---|---|
| At or above 10,000 feet AMSL (Above Mean Sea Level) | 8 kms | 1.5 kms horizontal, 1,000 feet vertical (above and below) | Nil |
| Below 10,000 feet AMSL | 5 kms | 1.5 kms horizontal, 1,000 feet vertical | Nil |
| At or below 3,000 feet AMSL or 1,000 feet AGL (Above Ground Level), whichever is the higher | 5 kms | Clear of cloud and in sight of the ground or water | Carriage and use of VHF radio required when operating to these conditions, for communication on the MBZ frequency or CTAF when within the prescribed distance of an aerodrome, or on the area frequency when en-route |

A glider shall not be flown above cloud covering more than one half of the pilot's downward field of vision for more than 30 minutes; and

NOTE: in controlled airspace a sailplane shall not fly above more than 4/8 cloud, and shall be able to fix position accurately by reference to the ground at any time.

If outside controlled airspace, be able to fix position accurately by reference to the ground at intervals not exceeding 30 minutes.

Nothing may be towed behind an aircraft in flight except with the permission of CASA

Nothing may be dropped from a sailplane in flight except:-

> ballast in the form of water or fine sand;
>
> ropes and cables with appropriate fittings used in launching sailplanes;
>
> components designed to be jettisoned in flight, such as drag parachutes or jettisonable wheels; or
>
> other items with the approval of CASA.

Parachute descents other than emergency descents shall only be made in a manner approved by CASA, for example, in accordance with the Operational Regulations of the Australian Parachute Federation.

Flight instruction and authorisation to a student for solo flying shall be such as to ensure that a sailplane flown by that student does not constitute a hazard to other aircraft.

A sailplane shall not be flown in aerobatic manoeuvres (that is, manoeuvres in which the angle of pitch or bank exceeds 60 degrees) without the written approval of CASA when it is:-

> below 2000 feet above the level of a Federal airport or licensed aerodrome within two nautical miles of that aerodrome; or
>
> in any other location below 1000 feet above the highest terrain or obstacle within a 600 metre radius of the sailplane

Before engaging in aerobatic manoeuvres the pilot in command of a sailplane shall ensure that:

> the proposed manoeuvres are permitted by the sailplane's Certificate of Airworthiness;
>
> all occupants of the sailplane are secured with correctly-adjusted safety harnesses;
>
> the safety harness of any unoccupied seat is made secure so that it does not foul any controls of the sailplane;
>
> all loose articles are removed from the sailplane or made secure in the sailplane; and
>
> the proposed manoeuvres will not bring the sailplane into close proximity with other aircraft.

A sailplane shall not take part in an airshow or flying display, or fly over a public gathering except in the course of arriving at or departing from an aerodrome or gliding site, unless written approval has been obtained from CASA and from the RTO/Ops.

A sailplane shall not fly lower than 1500 feet over a built-up area except in the course of taking off or landing at an aerodrome or gliding site, nor lower than 500 feet above the ground except:

when taking off at an aerodrome or gliding site, or being retrieved following an outlanding in a place which meets the dimensions for an Aircraft Landing Area.

when in the course of landing;

when completing a race in a gliding competition approved by CASA. NOTE: CAO 95.4 prescribes conditions for this'; or

when engaged in ridge or hill soaring.

When engaged in ridge or hill soaring a sailplane shall not be flown at a height lower than 100 feet whilst it is within 100 metres of any person, dwelling or public road.

A sailplane which is required to give way to another aircraft shall do so by passing behind it or, if passing in front or above or below that aircraft, shall keep well clear.

When two aircraft are on converging headings at approximately the same height, the aircraft that has the other on its right shall give way, except that:

power-driven heavier-than-air aircraft shall give way to airships, sailplanes and balloons;

airships shall give way to sailplanes and balloons;

sailplanes shall give way to balloons; and

power-driven aircraft shall give way to aircraft that are seen to be towing sailplanes.

Where two aircraft are approaching head on or approximately so and there is a danger of collision, each shall alter its heading to the right. A sailplane which is ridge soaring and has the ridge to its left shall give way by turning away from the ridge.

An aircraft that is being overtaken has right-of-way over the overtaking aircraft, which shall not overtake by climbing or diving to pass over or under the other aircraft. No subsequent change in the relative positions of the two aircraft shall remove this right-of-way until the overtaking aircraft is entirely past and clear. A sailplane engaged in ridge or hill soaring shall overtake by passing between the ridge or hill and the other sailplane. Other than a sailplane ridge or hill soaring an aircraft shall overtake another aircraft by passing to its right.

An aircraft in flight or on the ground shall give way to an aircraft landing or on final approach to land.

Where two or more sailplanes are approaching to land, the lowest sailplane has the right-of-way but shall not use this rule to cut in front of, or overtake, another sailplane on final approach. A power-driven aircraft shall give way to a sailplane which is approaching to land.

Where two sailplanes are at approximately the same height and both are approaching to land, the higher-performance sailplane shall give way to the lower-performance sailplane.

An aircraft which is about to take-off shall not do so until there is no apparent risk of collision with other aircraft.

An aircraft the pilot of which is aware that another aircraft is compelled to land shall give way to that aircraft.

Sailplanes shall maintain separation from other sailplanes and from tug aeroplanes towing sailplanes by at least 200 feet horizontally and vertically.

As far as practicable, when in the circuit area of a Federal airport or licensed aerodrome a sailplane shall be flown such that all turns are made to the left, except at those aerodromes where turns to the right are required by CASA.

When it is not practicable for a sailplane to comply with particular procedures, the pilot shall ensure that he/she avoids conflicting with aircraft which are complying with that procedure.

Wherever possible a sailplane arriving at an aerodrome shall track over the ground such that at least two turns, each of approximately 90 degrees in the circuit direction, are made prior to landing.

**Outlanding**

A sailplane may, in cases of necessity, be landed in any place having adequate approach paths and landing surfaces, and landing at such a place is not considered of itself an accident or incident.

Attention is directed to the fact that this Regulation does not confer on the operator of a sailplane any rights as against the owner or occupier of any land on or over which the operations are conducted, or prejudice in any way the rights and remedies which a person may have in respect of any injury to persons or damage to property caused directly or indirectly by any sailplane.

If a sailplane is landed on private property all reasonable actions shall be taken to obtain the permission of the landowner prior to removing the sailplane.

All gates should be left in the condition as found after removing a sailplane from private property where it has landed. Care shall be taken not to damage crop or disturb stock.

A sailplane shall not be aerotowed from a paddock without the consent of the landowner or his/her agent.

A sailplane shall not be aerotow retrieved from a site unless it meets the requirements for dimensions of an authorised landing area.

## Parachutes

A serviceable parachute shall be worn by each occupant of a sailplane taking part in a GFA recognised contest.

A parachute is not considered to be serviceable unless it has been inspected and repacked in accordance with the manufacturer's maintenance requirements. This may be carried out by a person qualified under CAR 30 or by a parachute organization approved by CASA. Unless a shorter time interval is specified, an inspection is valid for six months.

## Radio operation

A pilot may be authorised to operate radiotelephone apparatus installed in a sailplane after he/she has been trained by a gliding instructor holding a Flight Radiotelephone Operator Licence (issued by CASA) or Radio telephone Operator Authorisation, (issued by GFA) and has passed an oral examination in radio operation of an equivalent standard to that required to obtain a Flight Radiotelephone Operator Licence. This authorisation shall be notified by log-book endorsement.

For further information on radio operation and other requirements, see the GFA publication Airways and Radio Procedures for Glider Pilots

## Accidents and incidents

Accident - an occurrence associated with the operation of an aircraft between the time any person boards the aircraft with the intention of flight until the time all such persons have disembarked in which any person suffers death or serious injury as a result of being in or in contact with the aircraft, or the aircraft incurs damage or structural failure which adversely affects its structural strength, performance or flight characteristics, or the aircraft is missing or inaccessible.

Note: This is the legal definition of an accident, which takes no account of certain characteristics of the sport of gliding. A blowover, for example, does not come within the above definition, yet it is certainly an accident, since no one would deliberately let it occur. GFA would expect to hear about such an occurrence, even if it were not reported to BASI, because blowovers are usually total write-offs.

Incident - an occurrence to an aircraft other than an accident that affects or could affect the safety of its operation.

Any accident shall be reported to both the RTO/Ops and the Bureau of Air Safety Investigation (BASI) without delay.

An incident shall be reported to the RTO/Ops within 24 hours and to BASI within 48 hours.

Any sailplane involved in an accident requiring immediate notification to BASI may not be moved, other than to the minimum extent necessary to preserve life, without the prior approval of BASI, and shall be deemed to be in the custody of BASI.

Information to be notified in the event of an accident shall be:

- the type, model, nationality and registration marks of the sailplane;
- the name of the owner, operator and hirer (if any) of the sailplane;
- the name of the pilot in command of the sailplane;
- the date and time when the accident occurred;

- the last point of departure and the point of intended landing of the sailplane and the nature of the flight;
- the position of the sailplane with reference to some easily defined geographical point and the latitude and longitude of that position;
- the number of persons aboard the sailplane and, where by reason of the accident a person has died or been seriously injured,
- the number of members of the crew (if any) who have died or become seriously injured and, if the information is available, the names of those members;
- the number of passengers (if any) who have died or become seriously injured and, if the information is available, the names of those passengers; and
- the number of other persons (if any) who have died or been seriously injured and, if the information is available, the names of those persons;
- the nature and causes of the accident as far as it is known;
- the nature and extent of damage to the sailplane; and
- the physical characteristics of the area in which the accident occurred.

## High altitude flight

Supplementary oxygen shall be used by all occupants of a sailplane above 10000ft AMSL. Supplementary oxygen systems shall only be filled with dry breathing oxygen.

## Flight in controlled airspace

Other than in an emergency, a sailplane operating in controlled airspace shall only do so if an airways clearance has been obtained. No aircraft shall enter military or civil controlled airspace without a clearance.

If the pilot in command cannot comply with an airways clearance he/she must advise ATC immediately and request an amended clearance.

> NOTE: within controlled airspace a sailplane must be flown so as to remain within 5 nm of its nominal track.

When flying in controlled airspace, a pilot shall set QNH on the altimeter (see Glossary)

Note: QNH may be obtained by:

- obtaining the QNH or Area QNH from a briefing unit before take-off; or
- obtaining the Area QNH from a Flight service or Air Traffic Control unit, by radio in flight; or
- setting the aerodrome elevation on the altimeter prior to take-off.

For further information on altimetry, see the GFA publication Airways and Radio Procedures for Glider Pilots

The format of a position report in controlled airspace is:-

- NAME of ATC unit
- SAILPLANE (callsign)
- POSITION by distance and direction from nearest aerodrome etc
- AT (TIME in minutes past the hour)
- ALTITUDE or Flight Level

and if appropriate

- REQUEST CLIMB/DESCENT TO (altitude or Flight level) and/or
- REQUEST AMENDED TRACK VIA (proposed route)

Based on the above, a sample airways clearance (in this case to enter the Control Area for wave-flying) might be: -

*Melbourne Control, Glider X-ray Oscar Charlie, one-zero miles west of Bacchus Marsh at one-five (minutes past the hour), five thousand five hundred (feet), request climb to Flight Level one-five-zero.*

## Danger Areas, Restricted Areas and Prohibited Areas

Danger Areas are areas where the potential for an increased level of risk exists. Such areas may be light aircraft lanes of entry or areas of intense flying training or aerobatic activity. Gliders are permitted to fly in Danger Areas without prior permission, but extra care must be taken to ensure that the risk of confliction is minimised.

Restricted Areas are more hazardous than Danger Areas. Typically they are things like military gunnery ranges, explosives storage areas or security-restricted areas. They are not necessarily always active. Whether a Restricted Area is active or not may be ascertained by contacting an Airway Operations Unit, typically the nearest Flight Service Unit. Gliders are only permitted to fly in an active Restricted Area with the prior permission of the controlling authority (e.g. Army, Air Force) or the appropriate Airways Operations Unit.

Prohibited Areas. Gliders are not permitted to fly in Prohibited Areas under any circumstances.

Locations and dimensions of Danger, Restricted and Prohibited Areas are shown on Visual Enroute Charts (VECs), Visual Navigation Charts (VNCs) and Visual Terminal Charts (VTCs).

## Operations in Remote Areas

A "remote area" may be defined as an area of terrain in which it is difficult to gain access for the purpose of search and rescue.

Operations in such remote areas shall carry an Emergency Locator Beacon (ELB) or a marine Electronic Position Indicating Radio Beacon System (EPIRBS) and be accompanied by sufficient crew to retrieve the sailplane without outside assistance.

One of the designated crew shall be responsible for maintaining a Search and Rescue watch (SARWATCH) and initiating search action if necessary.

SAR action shall be initiated at 2100 hours local time, and in the event of outlanding the pilot shall activate the ELB or EPIRBS no later than that time.

Pilots operating in a remote area shall hold either a Flight Radiotelephone Operator Licence (issued by CASA) or a GFA radio operator qualification.

Pilots not resident in Australia shall hold a certification from the CFI of their home club that they are competent to fly in remote areas and are competent in the use of the English language. If they intend to operate within an MTAF or in controlled airspace, they shall apply in writing at least 8 weeks prior to arrival. GFA will then forward the request to CASA for processing.

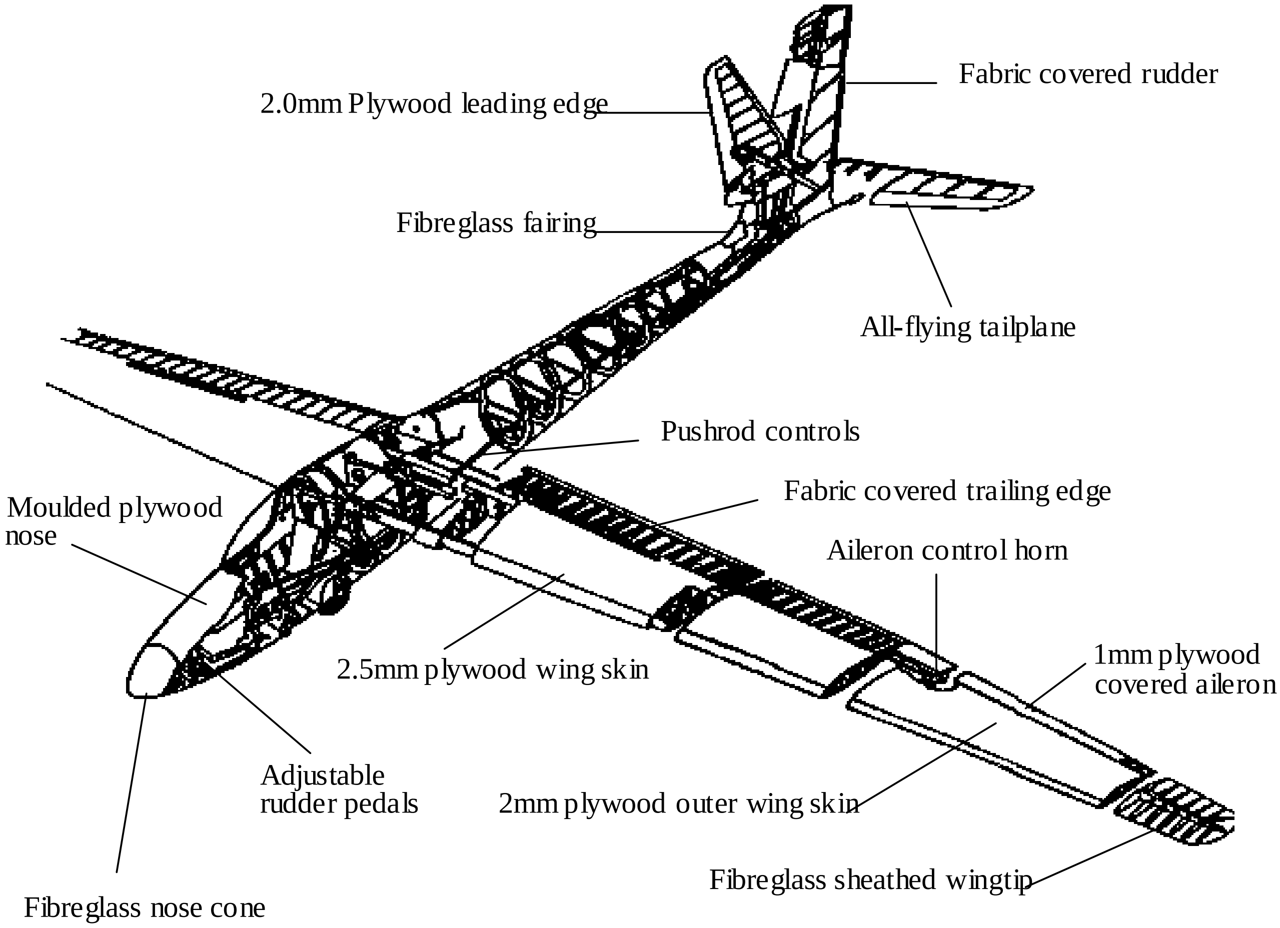
# CHAPTER 7 - BASIC AIRWORTHINESS

## GLIDER CONSTRUCTION

### Wood

Wooden gliders are no longer made commercially and the skills necessary to manufacture and maintain them are fast disappearing. There is nothing at all wrong with wooden gliders, apart from the above comments, and there are still plenty of them in service all over the world. Typical timbers used in glider construction are Spruce, Douglas Fir, Mahogany, Klinki Pine and Beech. Glues used in wooden gliders include Casein (a milk derivative), Resorcinol (a two-part synthetic glue requiring heat to cure the join) and nowadays one of the many Epoxy adhesives, such as Epiglue. Examples of wooden gliders flying in Australia are - Kookaburra and Boomerang (Australian), Skylark and Dart (British) and Ka6 (German).

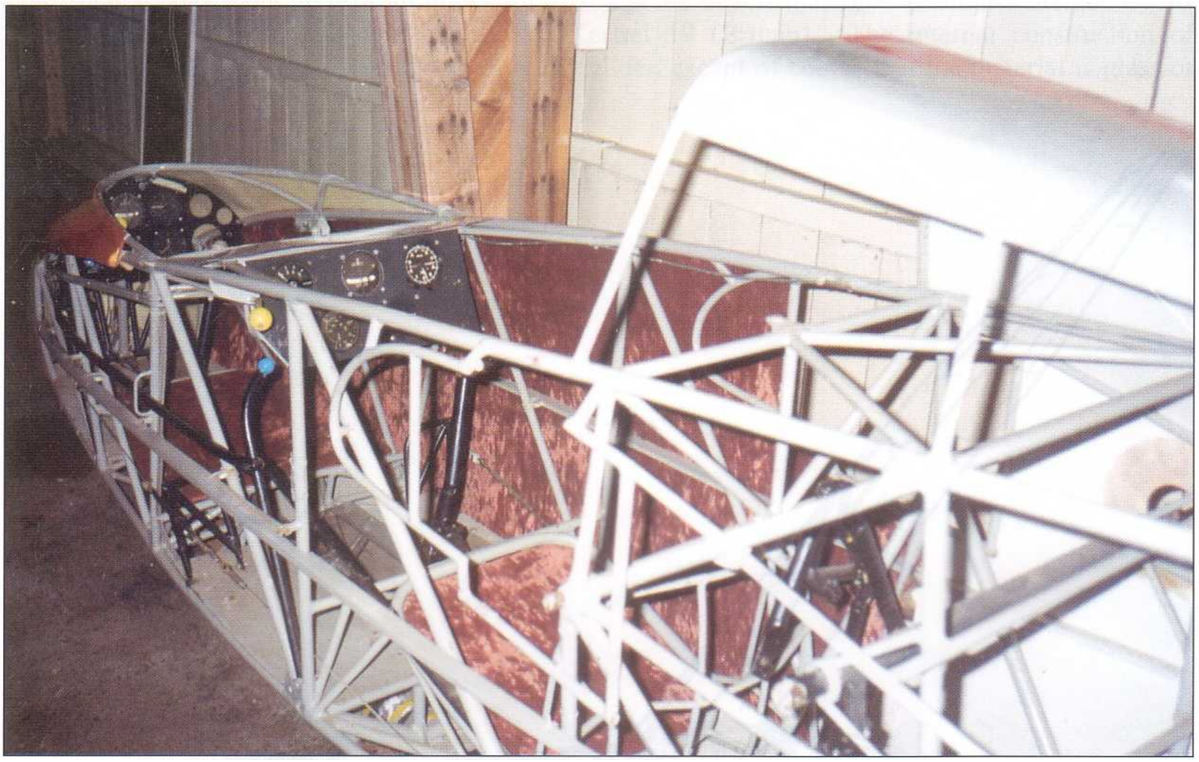
An example of wooden glider construction (Boomerang) is shown here.




**Schneider ES 60 BOOMERANG**

### Combined wood/steel-tube

Some gliders combine wooden wings and tail, with a fuselage of welded steel-tube construction. The steel-tube fuselage is covered with fabric. The illustrations below show (i) the front fuselage section of a Scheibe Bergfalke 2/55, and (ii) a Schleicher Ka3.

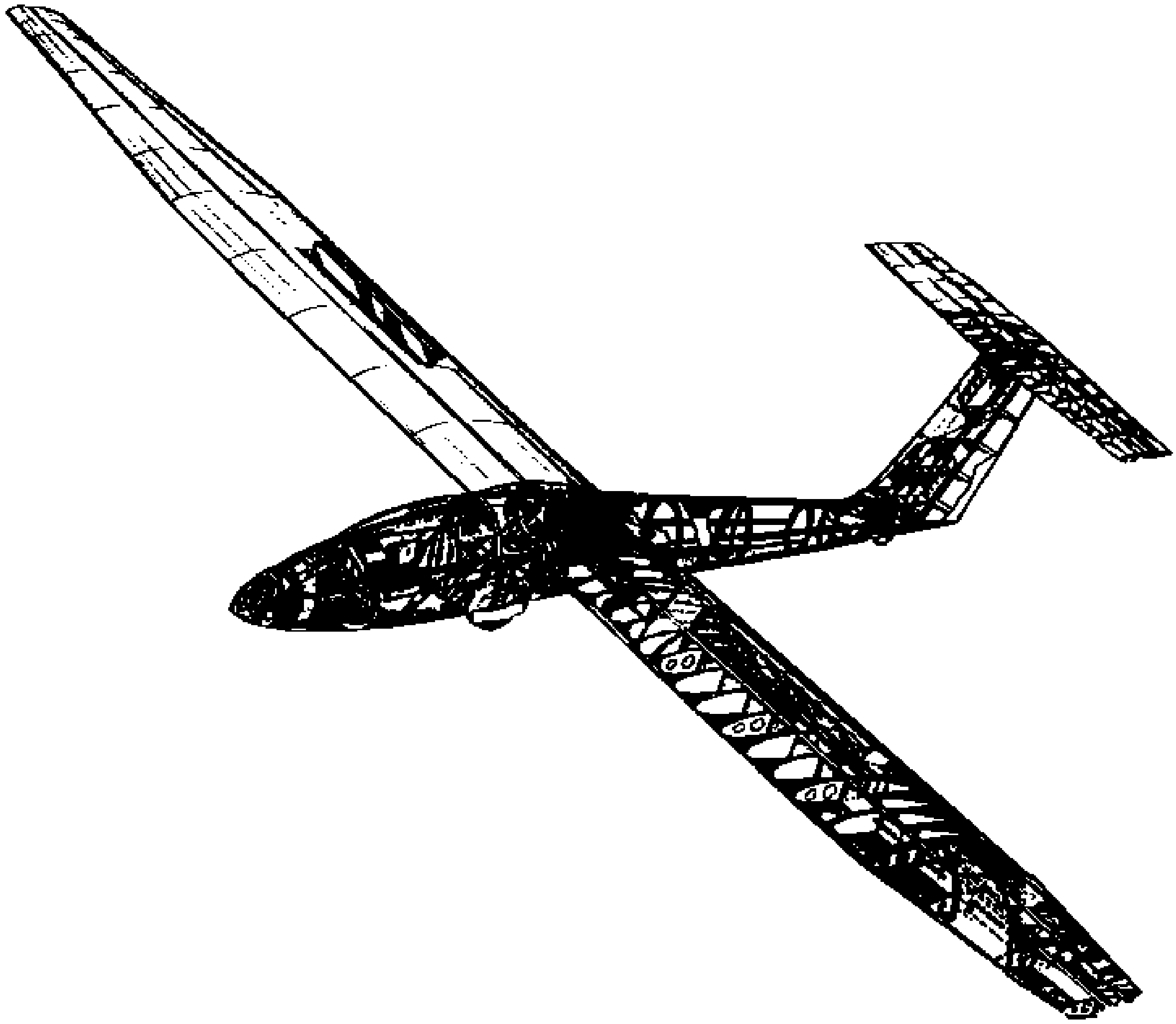


*(i)*

*(ii)*

## Metal

Metal gliders are usually constructed of riveted aluminium alloy, although special metal-to-metal bonding may also be used on some designs. Examples include Blanik (Czechoslovakia), IS28B2 (Romania) and Pilatus B4 (Switzerland). The Pilatus B4 appears below: -

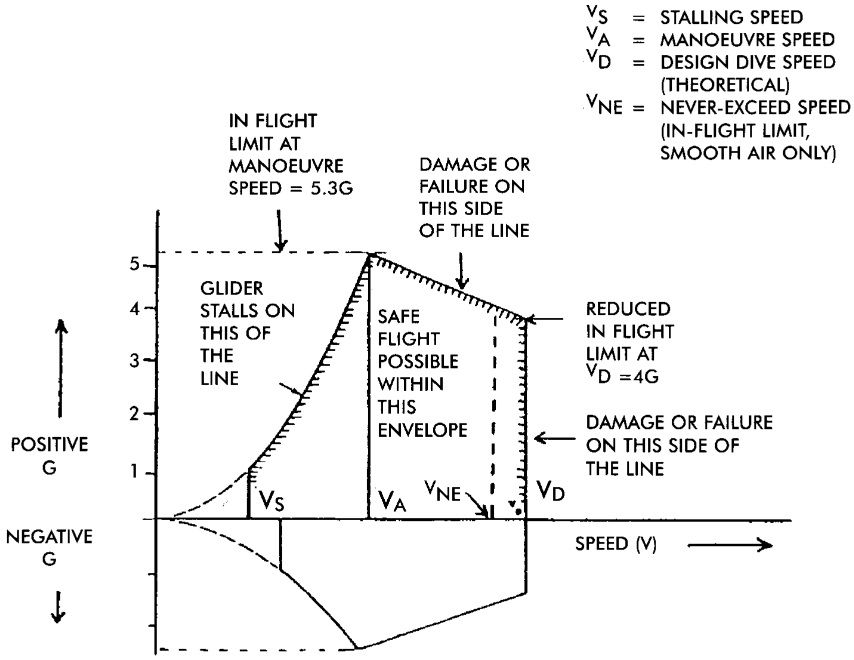


## Composite

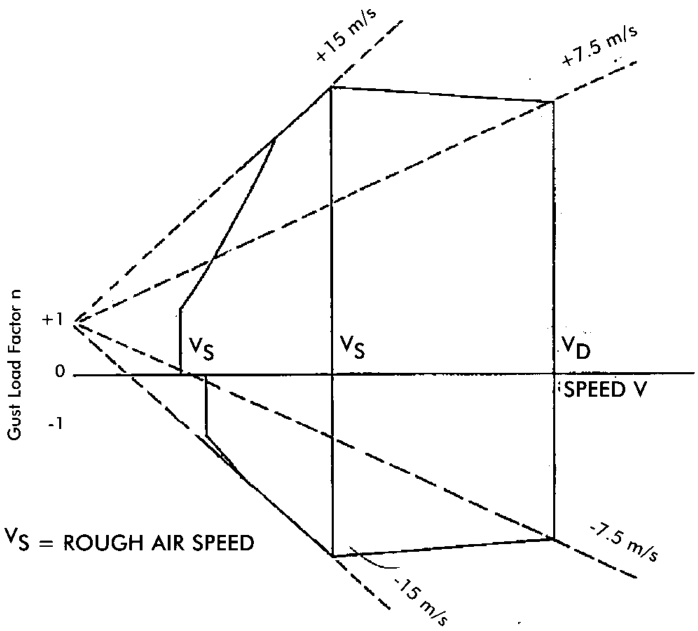
Composites are those materials usually known as glassfibre or carbonfibre. These consist of fibres of glass or carbon set in a resin (usually epoxy) and they offer enormous strength, great accuracy of shape and the ability to be constructed on a production line basis. Almost all modern gliders are of composite construction, and about 70% of all gliders in Australia are of this material. Examples include Cirrus and Libelle (Germany), Jantar (Poland) and Kestrel 19 (Britain). The internal construction of composite gliders is similar to a timber or metal glider, except of course that the material is glass or carbon fibre.

**FLIGHT LOADS AND GLIDER LIMITATIONS**

A glider is amazingly strong for its weight; that is its structure is very efficient. However it is not infinitely strong and certain limitations have to be placed on it if the flight loads are not to exceed the glider's capability to withstand them. This leads to an "envelope" of permissible speeds and load-factors (G loadings - see Glossary) within which the glider must be operated if its structural integrity is to be retained. Such an envelope, defining the glider's manoeuvring limitations in smooth air, is known as the MANOEUVRE ENVELOPE and a typical example is shown here:-




If the air is not smooth, in other words if gusts are present, additional stresses are applied to the glider. These are defined in the diagram below.



The information from the manoeuvre and gust envelopes of any given glider is extracted and presented to the pilot in the form of a simple cockpit placard

## GLIDER LIMITATIONS PLACARDS.

A typical glider speed and manoeuvres limitations placard appears below:-

**Airspeed Limits - Twin Astir**

| | |
|---|---|
| Never Exceed Airspeed | 135 Kts |
| Maximum Rough-Air Speed | 108 Kts |
| Maximum Manoeuvring Speed | 92 Kts |
| Maximum Aerotow Speed | 92 Kts |
| Maximum Winch/Autotow Speed | 64 Kts |
| Maximum Speed with Airbrakes Open | 135 Kts |

The permitted aerobatic manoeuvres will also be displayed, either on the same placard or on a separate one alongside. The maximum (and possibly the minimum) weak link strength will be displayed, internally on the placard and externally next to the release hook(s).

### Indicated airspeed and true airspeed

As altitude increases, the atmospheric temperature, pressure and density decrease. This means that the pitot pressure, measured at the opening of the pitot head on the glider, will be progressively less as the altitude increases, even though the glider is moving through the air at the same speed. Reduced pitot pressure means a lower indication on the airspeed indicator.

Therefore, as altitude increases, there is an increasing error between the speed shown on the airspeed indicator and the actual speed the glider is travelling at through the air.

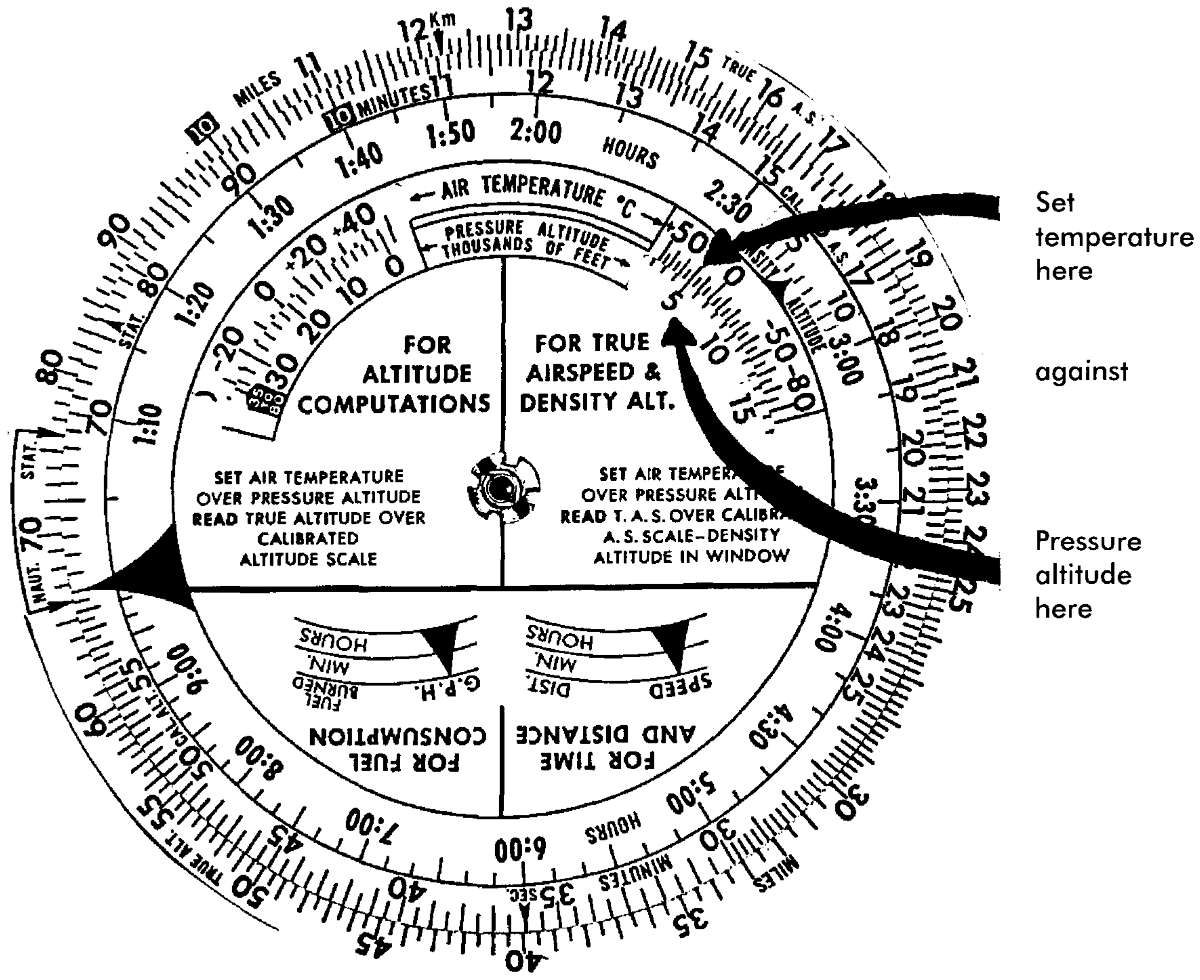
The speed shown on the airspeed indicator is called, fairly obviously, INDICATED AIRPSPEED (IAS). The actual speed at which the glider is travelling through the air is called the TRUE AIRSPEED (TAS).

There is no means of reading true airspeed on a glider instrument, unless the glider happens to have an airspeed indicator which has a sliding scale around its periphery for the purpose. Such instruments are common in modern light aircraft but very rare in gliders.

Calculating TAS from IAS involves applying an altitude and temperature correction to the reading on the airspeed indicator. This correction is easily calculated on a navigational computer. These computers are commonly used by light aircraft pilots, but again are seldom used by glider pilots.

One side of a Navigation Computer is for the purposes of "dead-reckoning" navigation. Thus it contains the compass rose and all the provisions for applying the wind-velocity to heading/track calculations. That side does not concern us here.

The other side of the computer comprises a circular slide-rule, commonly known as a "prayer wheel". An example of the IAS/TAS correction section of a typical prayer wheel is shown overleaf.




In the example shown here, a glider is flying at 5,000ft at an air temperature of 20 degrees and an IAS of 70 knots. Setting air temperature against pressure altitude in the right-hand window, then reading true airspeed on the outer speed scale from 70 knots on the inner speed scale, it will be seen that the glider is actually flying through the air at just over 77 knots.

The errors build up as altitude increases. A glider flying at the same 70 knots IAS, but at an altitude of 10,000ft and assuming a temperature at that altitude of 0 degrees C, results is a TAS of 82 knots.

Now lets go wave-flying. We are at 25,000ft and still flying at 70 knots. The temperature is -15 degrees C. Using these numbers, the prayer-wheel will tell us that we have a TAS of 108 knots. We are starting to creep up toward the glider's Vne; in fact we would be at Vne if the glider happened to be, say, a Club Libelle.

Does this matter? Surely the Vne is based on actual indications on the airspeed indicator, rather than some mysterious computation which most pilots don't understand anyway. This is generally true, except for one factor - flutter.

Flutter is an alarming and possibly destructive phenomenon which results from oscillations of a control surface exciting a main surface of the glider. For example, the ailerons could flutter and excite the wing into very large excursions up and down, which may eventually result in damage or complete failure. A similar interaction could occur between the elevator and the tailplane or the rudder and the fin. The onset of flutter can be rapid and can build up to destructive levels very quickly. It is a phenomenon better avoided than experienced.

What has this do with the IAS/TAS argument? Because flutter is an inertial problem, the value of inertia stored up in the aileron/wing or elevator/tailplane is a function of the TAS of the glider, not its indicated speed. The mathematics are not for this book, but you can take it as read that the INDICATED Vne of the glider must be reduced as altitude increases, in order to keep the flutter problem at bay.

Many modern gliders take this into account and their cockpit placards show a reducing Vne with increasing altitude. If you are going high, make sure you know the amounts by which you must reduce this Vne, especially if you are wave-flying and might need to use high speeds to jump wave-caps.

What about the older gliders and those modern ones which do not display this information to the pilot? You must still take a reducing Vne into account when flying at high altitude, but you will have to work it out for yourself. It is safe to say that there are likely to be few problems up to 10,000ft, but above that height you must shave increasing amounts off the Vne. As a guide of how much to shave off, if you don't have a prayer-wheel, take about 1.5% per 1,000ft off the placarded values.

Just to complete the IAS/TAS argument, it is not only flutter which might prove troublesome at altitude. Two other things should be taken into account when flying high:-

1. Rough air can be encountered during wave-flying, so SLOW DOWN if you meet clear air turbulence.

2. The reduction in air density results in a reduction in aerodynamic damping, which can adversely affect the natural stability of the glider. Some designs which have very light elevator forces and are only marginally stable in pitch at low altitudes may exhibit actual instability when flown at high altitude. This will be at its most marked when flying at a high TAS.

Remember, at high altitude, what you see is not what you get.

Why not beg, borrow or steal a navigation computer from a power-pilot friend and work out a few examples for yourself?

## WEIGHT AND BALANCE

As well as observing placarded speed and manoeuvre limitations, a glider also has to be operated within strict limitations of weight and balance. A pilot must be thoroughly familiar with these limitations on each glider he flies.

The following basic definitions are relevant: -

| | | |
|---|---|---|
| Empty weight | - | the glider's empty weight, equipped to fly, without pilot, parachute or removable ballast. |
| Gross weight | - | the maximum flying weight |
| Maximum pilot weight | - | the heaviest pilot with parachute that can be accommodated without exceeding gross weight or moving the CG out of limits. |
| Minimum pilot weight | - | the lightest pilot with parachute that can be accommodated without fitting removable ballast. |
| Removable ballast | - | Lead or steel blocks or cushions which can be fitted and secured in order to bring a pilot up to the minimum pilot weight. |
| CG range | - | the range of movement of the centre of gravity, presented to the pilot in terms of a maximum and minimum pilot weight. In the case of two-seaters, a sliding scale is often used in order to take into account the varying weights in each cockpit. |

A typical weight and balance placard follows –

**Payload (Pilot & Parachute) - Twin Astir**

| | | |
|---|---|---|
| **Maximum flying weight** | **650 kg** | **1435 lb** |
| **Minimum front cockpit for all flight** | **70 kg** | **154 lb** |
| **Maximum load front** | **110 kg** | **242 lb** |
| **Maximum load back** | **110 kg** | **242 lb** |

The maximum permitted weight must not be exceeded. The maximum pilot weight is important too, because it is likely that if it is exceeded the glider will be flown outside its forward CG limit. This may make it impossible to trim the glider to minimum sink speed and could make it difficult to flare the glider on the landing. More seriously, it could also result in the maximum calculated flight loads on the tailplane being exceeded.

The consequences of flying a glider outside the aft CG, that is with too light a pilot, are even more serious and could result in loss of control. The implications of flying a glider outside the aft CG limit are as follows.

- It will be unstable in pitch and possibly uncontrollable.
- It may be difficult or impossible to trim to a safe speed near the ground.
- If a spin is deliberately or accidentally entered, it may be impossible to recover.

NEVER fly a glider below its minimum pilot weight. If your weight is marginal and you are not sure whether you are quite heavy enough, add some ballast.

## AIRWORTHINESS DOCUMENTATION

The normal way of certifying the airworthiness of a glider is by issuing it with a Certificate of Airworthiness (C of A). To qualify for the issue of this document, the glider must be constructed to an accepted airworthiness code, such as OSTIV or JAR22 (see Glossary of Terms). Each individual glider is issued with a C of A, which is the source of the speed and weight limitations listed on the cockpit placard. Certificates of Airworthiness are issued for an indefinite period, but the day-to-day validity of the document from the pilot's point of view depends on the glider being maintained to GFA standards. Such maintenance is usually carried out annually and this fact is recorded in another document, which is carried in the cockpit of the glider (see "Maintenance Release").

Some gliders may not qualify for the issue of a C of A. There may be a variety of reasons for this, such as modifications to the structure or the installation of an add-on engine for self-launching. Such gliders may be issued with a Permit to Fly while engineering information is gathered to assess the suitability of the new machine for the issue of a full C of A. Permits usually, but not always, apply limitations to a glider which are not present in the case of a glider with a C of A. They are also issued for limited periods only (12 months, perhaps) and not for the indefinite period of a C of A.

### The Maintenance Release

This document certifies that the glider is being maintained in accordance with GFA requirements. It also validates the C of A or Permit to fly of the glider. It is issued by a GFA-qualified inspector and is renewed on completion of the relevant inspection. If a Maintenance Release is present in the glider and is within its validity period, the glider is legal to fly. Check this before flight.

Although it may be legal to fly, the glider is not necessarily airworthy to fly. For example, it may have suffered a heavy landing on its last flight the previous day and there may be damage present which, for some reason, the last pilot did not report and did not enter into the Major Defects section of the Maintenance Release. It is therefore a requirement for a glider to receive a Daily Inspection before it is allowed to fly on any given day. Each pilot flying the glider must check that the Daily Inspection has been carried out, before carrying out his own walk-round inspection prior to flight.

| MAINTENANCE RELEASE PART 1 | TYPE K 2 B | VH- GHO |
|---|---|---|

In accordance with the GFA Manual of Standard Procedures this Maintenance Release is issued following the completion of an annual inspection certified on GFA Form 2 dated ............

| Issued by: BENDIGO GLIDING CLUB | | Date of issue: 12.12.95 |
|---|---|---|
| Signed [signature] | 1109 G: 1125 | Date of expiry: 11.12.96 |

**EVALUATION FLIGHT REPORT**

This aircraft may not be flown other than for an evaluation flight unless this evaluation flight report is completed and any defects found recorded as Major/Minor defects as appropriate and Major defects corrected.

- ☑ General Handling at all speeds
- ☑ Stall
- ☑ Run to $V_{NE}$
- ☑ Spins (if applicable)

PILOTS SIGNATURE [signature] DATE 17.12.95

This Maintenance Release is issued subject to the conditions that the following maintenance and daily inspections as required by the GFA Manual of Standard Procedures are performed on the glider/powered sailplane during the period this Maintenance Release is in force.

## The Daily Inspection Record (GFA Form 1)

This is used to certify that a glider has received a Daily Inspection from a suitably qualified person. Check that the correct date appears alongside the Inspector's signature. If the correct date does not appear there, do not fly the glider - make some enquiries.

**DAILY INSPECTION RECORD GFA FORM 1**

**A signature and authorisation number on this form certifies, in accordance with the GFA Manual of Standard Procedures that at the start of a day's flying and after each rigging a Daily Inspection has been performed and the glider is considered fit for flight.**

| SIGNATURE & AUTHORISATION NUMBER | DATE | SIGNATURE & AUTHORISATION NUMBER | DATE | SIGNATURE & AUTHORISATION NUMBER | DATE |
|---|---|---|---|---|---|
| [illegible] G1125 | 12/12/95 | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

The Maintenance Release and the Daily Inspection Record share the same common booklet, which is kept in the glider at all times. It is a very important document and forms the link between the inspector who looks after the airworthiness of the glider and the pilot who flies it.

## WEAK LINKS

A weak link is inserted into the cable or tow-rope for the purpose of protection of the glider against overstressing during the launch. The specified maximum weak link strength will be found on the glider's limitations placard.

## FLUTTER

As discussed in the IAS/TAS section, flutter is an oscillation of a control surface which causes a sympathetic oscillation of the main flying surface to which it is attached. For example, a fault in the aileron circuit could cause aileron/wing flutter or an elevator could cause tailplane flutter. The cause may be faulty balancing of the control surfaces, excessive control system free-play or flying the glider outside its placarded limitations.

At any altitude, the general recommendation if flutter is experienced is to SLOW DOWN. When you get back to the airfield, ground the glider and advise an airworthiness inspector or the Duty Instructor.

## GROUND HANDLING - AIRWORTHINESS IMPLICATIONS

The primary purpose of proper ground handling is to protect the glider from being damaged by the obvious hazards of strong winds and collision with obstacles. However it is possible to cause hidden damage to gliders by the wrong kind of ground handling, damage which may not be apparent to the person handling the glider but which may accumulate to the extent that some other pilot may end up suffering the consequences. A few hints on what not to do are in order.

> Never apply large forces in a fore and aft direction at the wingtip. The most common application of this wrong technique is when two people are ground-handling a glider and they both pull forward or backward on each wingtip. Because of the long wingspan, this puts enormous stresses on the wing-root fittings, stresses which the designer did not intend.
>
> Do not lift a glider by its tailplane. Once again this causes stresses which are not designed for.
>
> Do not sit on the leading edges of parked gliders. It is primary structure and, although it will withstand pushing, it will not tolerate the full weight of a person sitting on it.
>
> If a glider gets bogged and a vehicle is used to pull it out of the soft ground, attach towropes to both towhooks of the glider to spread the load and avoid local overstressing of the towhook installation.

## RIGGING AND DE-RIGGING

There is no intention of going into any detail in this guide about the actual mechanism of rigging and de-rigging a glider. There are too many types of gliders in service to attempt that. Pilots learn the specific detail of rigging and derigging in their clubs and that system works very well.

However, every time a glider is rigged after an outlanding or a period in the workshop, it must receive a Daily Inspection. Even if it lands out twice or more in a day, this still applies.

**No D.I., no fly.**

# THE WALK-ROUND INSPECTION

Before starting the pre-takeoff checks, the pilot should walk around the glider to check for any obvious damage. This damage may be in one of the following categories :-

1. In-flight overstress caused by mishandled aerobatics, flying too fast in rough air or possibly the onset of flutter.
2. Heavy landing damage.
3. Damage accumulated during the day's routine operations.

In cases 1 and 2, it is likely that any such occurrences would be reported by the pilot(s) involved. However, this does not always occur and all pilots should develop a healthy curiosity about the overall condition of any aircraft which they fly.

The walk-round inspection need not take very long, a couple of minutes at most. Start at the cockpit and work around the glider in an anti-clockwise direction. You will be looking for the following signs of damage:-

## Heavy landings

Signs of overstress where the wings join to the fuselage. Gliders which have a wing carry-through structure in the fuselage (e.g. Blanik, Bocian, IS28B2) may also show signs of stress in this structure. The reason for damage in this area is the tendency of the wings to move rapidly forward and downward in a heavy landing.

Signs of damage to the fuselage in the vicinity of the undercarriage.

Signs of wing damage due to the rapid downward flexing of the wing. In fabric covered gliders, this damage often shows itself as broken trailing edges.

## In-flight overstress

Signs of excessive 'G' loading in aerobatics, often in the form of cracking around the edges of the airbrake box, although there may also be other obvious signs. Check upper and lower wing surfaces.

Signs of overspeeding. One likely place to find damage will be underneath the tailplane, where there may be some signs of compression failure of the skin due to the large download on the tailplane which most gliders experience at high speeds. Overspeeding may also have caused flutter, which may manifest itself in loose control surface hinges and other similar damage.

## Routine operations

Signs of damage from rocks thrown up by cable drogue-chutes during winch/auto take-offs.

Signs of fasteners working loose on fairings or hatches, usually due to operations on rough ground.

## General advice

If suspicious about anything you find on a walk-round inspection, don't fly the glider. Have it inspected by a qualified inspector. It's better to be down here wishing you were up there than to be up there wishing you were down here.

# DAILY INSPECTIONS - POLICY

## General

It is a GFA requirement that all gliders receive a Daily Inspection (DI) before flying. The person carrying out the inspection must be adequately trained and hold a Daily Inspector authorisation.

A Daily Inspection is required:-

1. Before the first flight of the day.

2. After rigging the glider.

Common sense suggests that a decent Daily Inspection helps to prevent accidents, by showing up significant faults in the glider before it flies. A person holding DI authorisation therefore plays an important part in accident prevention. Such a person must operate with a high degree of integrity, as the glider is being inspected for everyone's benefit on that day, not just for one individual.

## Pre-requisites for becoming a Daily Inspector

1. Be a member of GFA.

2. Be a solo pilot or have suitable background experience (e.g. L.A.M.E. or aircraft apprentice) to assist in obtaining the authorisation.

3. Be at least 15 years of age.

4. Satisfactorily undertake a test as to his/her competence.

## Procedure for becoming a Daily Inspector

As well as experienced airworthiness inspectors, any gliding instructor of Level 1 or higher rating is authorised to assist in the training of Daily Inspectors. By this means, a person may learn about DIs during flying training. The reference for the training is the Daily Inspector handbook.

When the training has been completed, the person undertakes an independent competence test.

If the test is satisfactory, the person's logbook is appropriately endorsed. If not satisfactory, the person is returned for further training.

# DAILY INSPECTIONS - PRACTICAL

## Purpose

There are five reasons for carrying out a Daily Inspection, viz,

1. To check for progressive deterioration caused by fair wear and tear.
2. To check for unserviceabilities or sudden deterioration which fall outside the category of fair wear and tear.
3. To check for unreported damage.
4. To check that the glider is correctly rigged and the control circuits are properly connected and locked.
5. To check that there are no tools or other loose objects lying around after maintenance.

When carrying out a DI, it is sometimes difficult to work out how far to go, how deep an inspection to do. Using the above five points as a guide, the answer is to go deep enough to satisfy your curiosity as to whether the glider can safely fly, without going to the extent of starting to overhaul it. A DI is basically a visual inspection, using only those tools which are necessary to gain access to essential parts of the structure, such as wing roots or underneath nose fairings.

All gliders receive at least an annual in-depth inspection and we strongly encourage pilots to carry out walk-round inspections before flight. The DI therefore bridges the gap between the two. The five points listed will now be covered in more detail.

## Progressive deterioration, fair wear and tear

Typical items on a glider which can deteriorate slowly over a twelve-month period are:

- Wear in control cables
- Lack of lubrication
- Ingress of dirt into control circuits
- Excessive free play in hinges and bearings
- Signs of fatigue in metal structures
- Cracking at stress points in all structures
- Frayed or worn harnesses

This list is not exhaustive, but will give a good idea of the kind of thing to look for under the heading of fair wear and tear.

## Unserviceabilities, sudden deterioration

Examples of sudden deterioration include:-

- Broken release springs
- Water or insect nests in pitot/static systems
- Instrument or radio failure
- Flat tyres
- A failed component in a control circuit

Again, not exhaustive, but gives an idea of what can happen suddenly and unpredictably in normal service.

### Unreported damage

This is outside the category of normal service and occurs when the glider is either flown outside its permitted limits or is damaged in some way on the ground. Examples include:-

- In-flight overload, typically caused by mishandled aerobatics or flying too fast in rough air.
- Heavy landing
- Ground loop on take-off or landing
- Storage damage ("hangar rash")

### Correct assembly and rigging

Although always important, particular attention must be paid to this category if the glider has just been rigged, such as following an annual inspection or after a cross-country outlanding. Examples of items in this category which require checking are:-

- Controls are properly connected. This is checked by one person firmly holding each control surface in turn, while another person tries to move the stick or pedals in the cockpit.
- No restriction in the movement of the controls and the range of movement is correct
- Controls operate in the correct sense. Several cases have occurred of gliders becoming airborne with reversed controls, having escaped several stages of inspection.
- Pins are safety-locked and any tapered pins are fully home
- Locknuts are in safety
- Turnbuckles are correctly locked and in safety
- Castellated nuts are properly connected and safety-locked
- Hatches and access panels are securely fastened after use

### Loose objects, tools, etc

This heading is really self-explanatory. A DI Inspector must have a high degree of curiosity, bordering on suspicion, when it comes to the possibility of things lying around inside gliders. A torch is handy for DIs, for poking around in some of the darker recesses, provided of course that the DI inspector doesn't leave it in the glider!

Dirt in the cockpit can be as hazardous as any other solid object, when it comes to the possibility of jamming a control circuit. Dried mud and clumps of grass off pilots' feet can work their way under floorboards and end up among pushrods, torque tubes and cables, where they can get up to all sorts of mischief. Vacuum-cleaning of cockpits is a regular DI chore and must not be by-passed just because you are not in the mood or the power-point is far away. The risk of jammed controls far outweighs any inconvenience in keeping the interior of the glider clean.

### Finally

Talk to your club instructors or airworthiness inspectors about DI training. Such training gives a good insight into the construction and control systems of the aircraft you fly, and may encourage you to seek more extensive qualifications in the airworthiness field. It will also make you a more informed and sympathetic pilot. The reference document for learning about DIs is the GFA Daily Inspector's Handbook.

# CHAPTER 8 - BASIC NAVIGATION

When a glider goes cross-country, the basic principles of navigation apply. This chapter will outline these principles in a way that will give sufficient information to help a new cross-country pilot to avoid getting lost or straying into an area where he should not be.

## Maps and charts

The most common type of map used by a glider pilot is the World Aeronautical Chart (WAC). The projection used on these maps is Lambert's Conformal Conic, a fact which is of little interest to a glider pilot. The scale used on a WAC chart is 1:1,000,000, which is of great interest to us. Such a scale means that large areas of country are covered by a single map, avoiding as far as possible the unpleasant business of trying to change and unravel maps in flight. However, Australia is such a large country that carrying more than one map is sometimes unavoidable. The WAC scale gives relatively little detail, but in fact provides enough for the commonly used turning points and navigation check points used by glider pilots to be quite easily identified. An example of a section of WAC chart appears here.


WAC charts are available from flying schools on many aerodromes or contact the Civil Aviation Safety Authority Publications Centre, P.O. Box 1986, Carlton South, 3053. The Australia-wide free call is 1800 33 1676 or 9342 2000 if you are calling in the Melbourne area.

**DON'T LEAVE HOME WITHOUT THE RELEVANT WAC CHART**

Some knowledge of other charts is needed by glider pilots, mainly for recognition of where controlled airspace is located and what tracks need to be planned to avoid such airspace. Flight by gliders in controlled airspace is possible, but it does need special clearance, two-way radio contact and in some cases the carriage of a secondary radar transponder. In the early stages of cross-country flying in gliders, controlled airspace is best avoided.

Consult your club's Instructor Panel for information on additional charts for use in cross-country flying. The charts vary from time to time and there is a risk of the inclusion of such information in this book becoming out-of-date very quickly.

## Track, drift, heading

When planning a cross-country flight, one of the first things a pilot does is to draw lines on the map from the departure point to either the goal destination or to various turning points on a closed-circuit task. These lines represent the path to be followed by the glider over the ground. The correct term for such a line drawn on a map is the TRACK. To be finicky about it, the strictly correct term would be Track Required, but the important thing to remember is that the track followed by the glider over the ground is not necessarily the same as the direction in which the glider is pointing in the air.

If there is no wind blowing, the direction in which the glider is pointing in the air will exactly match the track over the ground. But this is not a realistic situation; there is always some wind blowing and this affects the glider's ability to track exactly where it wants to go. For example, if the glider wants to track due north and there is a westerly wind blowing, the glider would be blown off track. The amount by which it is blown off track is known as DRIFT. Before going any further, two points must be made :-

The glider's direction in the air is always referred to in terms of the direction it is pointing TOWARDS.

The wind direction is always referred to in terms of the direction it is blowing FROM.

If you think about it a bit further, it will be apparent that there will be no drift if the glider is flying either directly into wind or directly down-wind.

Finally, the direction in which the glider is pointing in the air (which we now know is not necessarily the same as the track it is following over the ground) is known as the HEADING.

## Airspeed and groundspeed

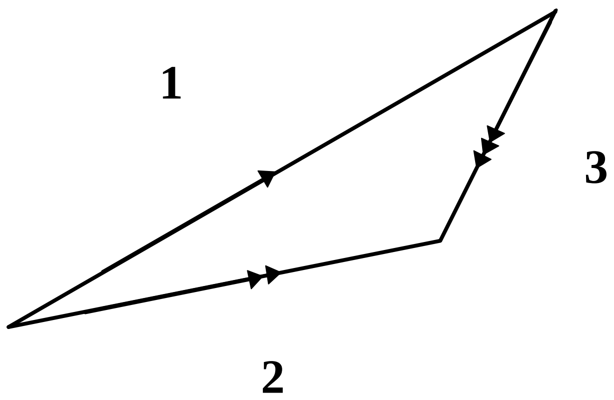
The speed of the glider through the air is known rather obviously as its AIRSPEED. There is no particular mystery about this, except that we now know from Chapter 9 that the indication on the airspeed indicator is somewhat affected by air density and for that reason there is an increasing error in the airspeed indication as the glider climbs to higher altitudes where the air is less dense. However, for the purposes of this exercise in basic navigation, such density errors will be ignored.

If there is no wind, the speed of the glider over the ground will be exactly the same as its speed through the air. Combined with the fact that there is no drift in such circumstances, navigation is very easy - the glider goes where it is pointed and gets there at a predictable rate of progress.

Life gets more complicated when the wind starts blowing. If the wind is blowing in exactly the same direction as the glider is pointing, in other words we have a tailwind, the speed over the ground will be higher than the speed through the air. There will be no drift (track will be the same as heading), just a HIGHER GROUNDSPEED.

Conversely, if the wind is blowing in exactly the opposite direction to the glider's heading, once more track and heading are the same but this time we have a LOWER GROUNDSPEED.

Let's bring all these points together in a diagram. The standard way of expressing in pictorial form the way in which the wind affects direction and speed of a glider is a diagram known as the TRIANGLE OF VELOCITIES. Note that the term "velocity" is quite specific; it means a combination of speed and direction.




In the triangle of velocities diagram, note the following points: -

1. Glider heading, represented by one arrowhead. Anticipated distance travelled represented by the length of the line.

2. Glider track, represented by two arrowheads. Actual achieved distance after being affected by the wind is represented by the length of the line.

3. Wind velocity, three arrowheads.

Remember once again that the wind is always measured by the direction it is blowing FROM. It is very easy to get confused. Something else to confuse you is the fact that the wind velocity line on the diagram is in fact a VECTOR, which means that, as well as the line representing the direction from which the wind is blowing, the length of the line represents the actual strength of the wind. The longer the line, the stronger the wind. This will have an obvious effect on the drift, which is exactly what the diagram is meant to convey.

Referring back to the diagram, you will see that a cross-wind affects ground-speed as well as drift. A wind blowing at 45 degrees onto the nose of the glider will have the obvious effect of drifting it off to one side, but it will also have the less obvious effect of slowing it down. The diagram shows clearly that the track line is shortened, which means that the glider has slowed down and will not make the expected distance in the time originally planned. Try drawing a few triangles of velocities with the wind coming from various directions at different strengths and you will see the infinite variety of results which come out of the exercise.

## Correcting for drift

It is all very well to realise that the glider will experience drift when exposed to a crosswind. What we really need to do is work out how to correct the situation. It is not difficult to do - all that is necessary is to determine how much drift is occurring and change the glider's heading to compensate. If the glider is drifting 10 degrees to the right of its required track, an alteration of heading by 10 degrees to the left will compensate. However, this will only work if the pilot either knows beforehand that this amount of drift will occur or is astute enough to recognise instantly in flight that the glider is experiencing this drift angle. If the glider is allowed to drift some distance off track, a great deal more compensation will have to be made than the bare 10 degrees used as an example here.

It is possible to work out very accurately the amount of drift compensation necessary. The calculations involved in such an exercise can be performed on a Navigational Computer, a device owned by almost all power pilots and by very few glider pilots. Since accurate track-keeping is neither possible nor desirable in gliders, because we need to follow thermals, a basic understanding of the principles and concepts of the triangle of velocities is sufficient.

## Use of the compass

Any glider used for cross-country flying should carry a magnetic compass. It is the most basic of all navigational instruments and is very simple to use. There are just a few fundamental principles which need to be known.

Divisions of the compass. The compass is divided up into 360 degrees, which may be shown as the actual number of degrees (clockwise from North and back to North again) or possibly by named divisions (NE, SW, NNW, etc). Conventional aviation practice is to use the number of degrees clockwise from North. For example, a north-easterly track would be described as 045 degrees, south-westerly as 225 degrees.

Use of a compass in flight is only practicable if the aircraft is on a fairly constant heading. This allows the rotating part of the compass to settle down and the pilot can then get sensible readings from it. A glider, which spends much of its time circling, makes reading a compass very awkward. The pilot must make the best use of straight flight between thermals to get the readings he needs. Some special glider compasses, like the British "Cook" compass have a so-called "dead-beat" property, which dampens most of the swinging tendency. Such a compass is recommended, if you can get one.

Magnetic North. The needle of a compass does not point to True North, that is the North Pole on the ordinary geographical map. It points to an entirely different place on the surface of the earth, a point known as Magnetic North. It does not really matter exactly where Magnetic North is (as a matter of interest it is somewhere between Canada and Greenland), as long as we know that there is a difference between the two Norths. This difference is known as VARIATION. The actual value of variation at any given point on the earth's surface, in number of degrees, is shown on a WAC chart by the purple dashed lines known as ISOGONALS.

Let us imagine that you look at your map before a cross-country flight and you see that the variation in the area of your intended track lines is, say. 10 degrees East. This means that there is 10 degrees of difference between the isogonals and the grid lines in that part of the world. If you try to get to the point you have marked on your map without taking this variation into account, you will go astray.

The pilot must add or subtract the variation to the chosen heading to fly on the compass. But how does he know whether to add or subtract? Fortunately a little jingle comes to our assistance here. If the variation is west, the pilot will add the variation to the compass reading. This results in the magnetic heading being greater than the true heading. The opposite is the case for easterly variation.

VARIATION WEST, MAGNETIC **BEST**. VARIATION EAST, MAGNETIC **LEAST**

## What if you get lost?

Every pilot gets lost at least once. Some pilots make more of a habit of it than others. It is impossible to cover all contingencies in a book such as this, so a short check-list of recommended actions is offered:

DON'T PANIC. Realisation that you are lost is an unpleasant feeling, but it's not the end of the world.

If you have been using the compass for basic track-keeping, go back to it and establish the last heading you were flying to maintain the track you wanted. Keep flying that heading until you find something that you can identify.

If, in spite of all your efforts, you are still well and truly lost, it is best to land as soon as you can in the safest available landing area. This is certainly true if you are not very high (say below 3,000ft AGL).

If you are high (say above 8,000ft AGL) and it is getting late in the afternoon, it will get dark on the ground while it is still quite light up at your level. It takes a modern glider like a Discus about three-quarters of an hour to descend from 8,000ft to circuit height in still air at minimum sink speed, so you will need to make a determined effort to get down into a safe landable area, even though you don't know where you are. This means that a conscious decision must be made to stop worrying about your whereabouts and concentrate on a safe landing. There will probably be someone on the ground who will be delighted to tell you where you are.

If you have a radio on board, when you realise that you are lost, TELL SOMEONE. There is plenty of help available and many pilots have been steered back to an area they recognise by talking to other glider pilots in the air or on the ground.

After you have landed and have located a telephone, make contact with your base as a matter of first priority. This is of paramount importance, because the people back at base will be compelled to take Search and Rescue (SAR) action on your behalf if they hear nothing from you.

## Golden Rules to prevent getting lost

There are some golden rules for visual navigation :-

1. Never go cross-country without the relevant maps.

2. Always read from the map to the ground, never from the ground to the map. Although the latter technique can be made to work for some of the time, it has the unfortunate side-effect of convincing you that the feature you are trying to identify is the one you **want** to see, not the one that it really is. Once this has occurred, getting lost is a virtual certainty. Much better to pick out the features from the map (silo, road/river intersection, etc) and search for them on the ground. Its just as easy to do and works every time.

3. In summer, the sun tracks from due east to due west. In winter it tracks from north-east to north-west. Fence lines run north-south and east-west.

# CHAPTER 9 - BASIC SOARING METEOROLOGY

The real art in becoming a soaring pilot lies in a good understanding of the weather. In Chapter 1 we covered the various types of weather conditions which enable a glider to stay in the air, gain height and maybe fly cross-country. Now we will cover in a little more detail the aspects of weather which a glider pilot needs to understand in order to use his glider to optimum effect.

## ATMOSPHERIC STABILITY AND THE DRY ADIABATIC LAPSE RATE

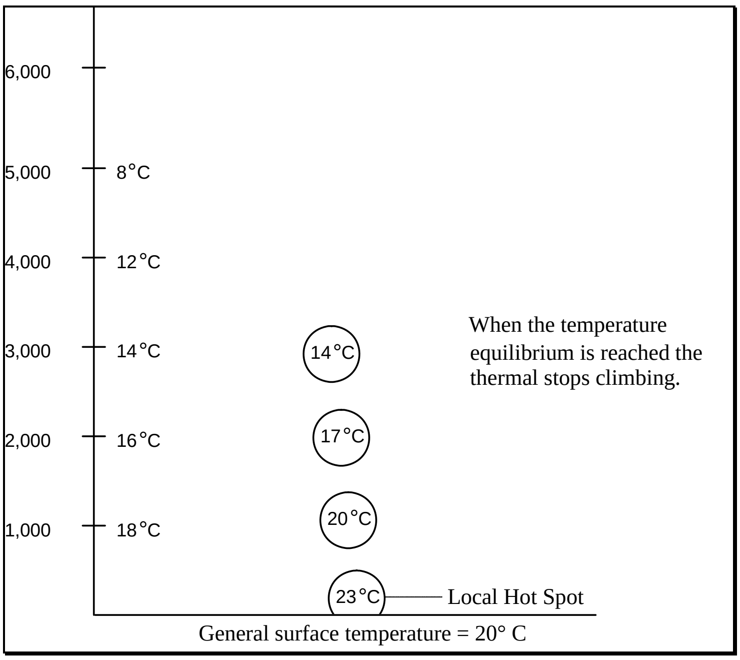
One of the factors which govern whether a glider is likely to be able to soar or not is the "stability" or "instability" of the atmosphere. The definition of these terms is essential knowledge for the soaring pilot. Briefly, the two terms can be described as follows:-

### Stability

A thermal comes into existence because the sun heats a particular area of ground to a higher temperature than surrounding terrain. The heated ground in turn heats the air immediately above it. Eventually this air will rise because it is warmer than the air which surrounds it. It will continue to rise for as long as it remains warmer than the general atmosphere around it.

As a general rule, the temperature of air gets less as the height above the earth's surface is increased. This rule applies to thermals as well as to the atmosphere generally. Thermals always cool at a fixed rate, which is 3 degrees Celsius for every 1,000ft gain of height. The general atmosphere may or may not cool at this rate - sometimes it is more, sometimes less. It varies from day to day.

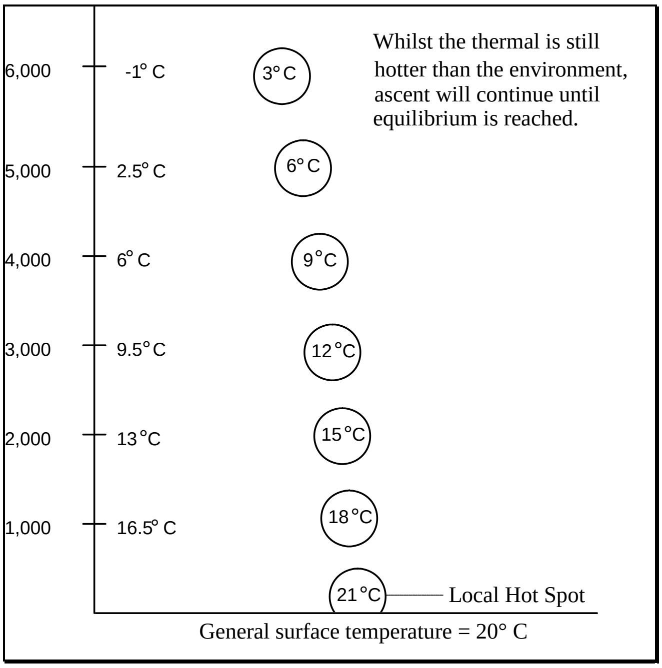
If a thermal (cooling at 3 degrees per 1,000ft) rises above a local hot-spot on the ground and the surrounding (or environmental) air is cooling at the rate of 2 degrees per 1,000ft, the thermal soon gets to the stage where it cools to the same temperature as its surroundings. At this point it stops ascending and such conditions are said to be stable. Stable conditions are not generally regarded as being very good for thermal soaring, but they can work quite well in the height of an Australian summer, when there is a lot of sunshine and local hot-spots become very hot indeed. Such stable days are very late starters, it being quite common to wait until 3pm before thermals are rising to usable levels. When they do get going, though, they are often strong and go to considerable heights. The following diagram illustrates the basic principle of atmospheric stability



The change in temperature with an increase in height is known as the "Lapse Rate". The rate of 3 degrees per 1,000ft, at which a thermal always cools in clear air, is known as the Dry Adiabatic Lapse Rate (DALR, being dry air, cooling without mixing of air with its surrounds). The rate at which the surrounding air cools is known as the Environmental Lapse Rate (ELR).

## Instability

As might be imagined, instability is the reverse of stability. Once again, a thermal cools at the DALR as it ascends. If the ELR in this example is 3.5 degrees per 1,000ft (a bit extreme, but it could happen), the thermal remains hotter than its surrounds as it climbs. This encourages the thermal to keep climbing until the environmental air changes its pattern and the two temperatures equalise. See diagram.




The above arguments apply to "dry air" thermals. A different set of rules apply if we introduce some moisture into the air.

## DEW POINT

There is always some moisture in the atmosphere. Even the hottest Australian summer day will contain some moisture in the air, even though the actual amount may be very low. The unseen moisture which is present in the air is known as water vapour and the ability of the air to hold this water vapour in suspension depends on the air temperature. The hotter the air, the more water vapour can be present.

When the air is cooled, its ability to contain the water vapour is reduced. A point is reached where the air temperature is too low to keep the water vapour in suspension any longer and it condenses out into visible water droplets. These water droplets are what we call cloud.

The temperature at which the air transforms its water vapour into visible water droplets is called the DEW POINT.

## THE SATURATED ADIABATIC LAPSE RATE

We know that a thermal cools at a fixed rate as it ascends in clear air. We also know that it probably contains a fair amount of invisible moisture. The thermal may keep ascending until a point is reached where it has become so cool that the moisture can no longer exist in suspension in the air and it condenses into visible droplets. The air has been cooled to its Dew Point and a cloud has been formed.

As soon as the cloud is formed, the air is said to be saturated. At this point, latent heat is released due to the change of state from water vapour to visible water droplets. This release of heat slows down the rate of cooling of the thermal. Thermals ascending inside clouds cool at a rate less than their lapse rate in clear air. They cool at about 1.5 degrees per 1,000ft in saturated air (it varies a bit, but this is reasonable guide). This new rate is known as the SATURATED ADIABATIC LAPSE RATE (SALR).

The combination of high moisture content of the air, a high degree of surface heating and an unstable ELR results in a tendency for large convection clouds to form. This is the breeding ground for thunderstorms. A weather forecast which contains warnings of these conditions being likely must be treated with great caution by the soaring pilot. The attraction of instability can turn into the destructive power of a convective storm in a very short time indeed.

## PRESSURE PATTERNS

Most of us are familiar with the weather maps presented on television and in the newspapers. The patterns of high and low pressure follow a set of natural laws which we should try to understand if we are to predict the likelihood of soaring conditions.

The basic principles are very simple. Air decreases in pressure with an increase in height. It also decreases in temperature because the air expands as it ascends (air will always cool when expanded and heat up when compressed - remember the warming of a bicycle pump when you pump up a tyre). If large- scale heating of the air occurs at the surface of the earth (over a desert, for example), there will be similarly large-scale lifting of the air over that region. This results in pressure variations at high level. This in turn affects the pressure at the surface, because of the variation in the pressure exerted by the "columns of air" above the various points on the earth.

Variations in surface pressure around the world create a flow of air (wind) from high to low pressure. Winds are simply the result of nature trying to equalise the pressure over the earth's surface. They never quite succeed in doing this, which is why there is always some wind blowing somewhere in the world.

There is just one complication. Although the wind tries to blow in a straight line from high to low pressure, the rotation of the earth does not allow this to happen. The straight high-to-low flow is bent into a spiral pattern as the so-called "coriolis" force of the earth's rotation exerts its influence.

The result of this coriolis force is that winds in areas of high pressure tend to blow anti-clockwise around the centre and areas of low pressure develop a clockwise rotation. This is the situation in the Southern Hemisphere. In the Northern Hemisphere the rotation is the other way round.

Areas of low pressure are known as depressions, or in an extreme form, cyclones. Low pressure implies an unstable air mass, because the air is always trying to rise inside a depression. For this reason, depressions can become violent if heated by tropical temperatures and they may turn into cyclones (hurricanes or typhoons in the Northern Hemisphere). Even if they do not turn violent, depressions are generally fairly windy areas.

Anticyclones imply a subsidence of the entire air mass towards the surface. This creates a stable air mass, inhibiting thermal development. For this reason anticyclones are generally benign in terms of bad weather, except that they can encourage the development of fog under some conditions. They are generally areas of light winds, although quite strong winds may precede an impending change in the weather, especially in southern Australia.

Pressure systems move from west to east in Australia. Processions of anticyclones and depressions are in perpetual motion across the continent. They are accompanied by disturbances in the weather which directly result from their interaction with each other.

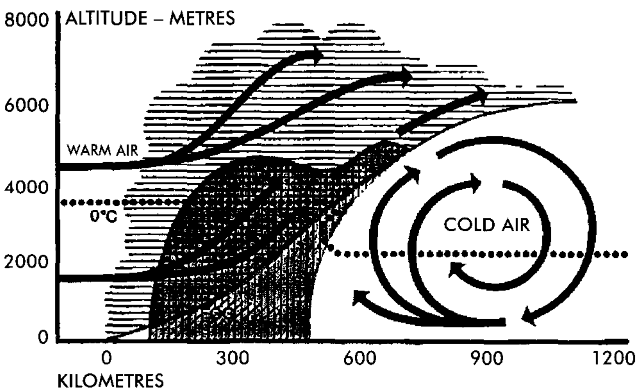
## FRONTS

Air is not a good mixer. Air masses of two different temperatures can exist alongside each other for a long time without any sign of mixing, although eventually they will show signs of starting to mix.

When air flows from high pressure to low pressure, the chances are that a temperature difference will occur due to the introduction of "new" air to "old" air. The two masses of air will not mix and a demarcation line is formed between the two. This line is known as a FRONT.

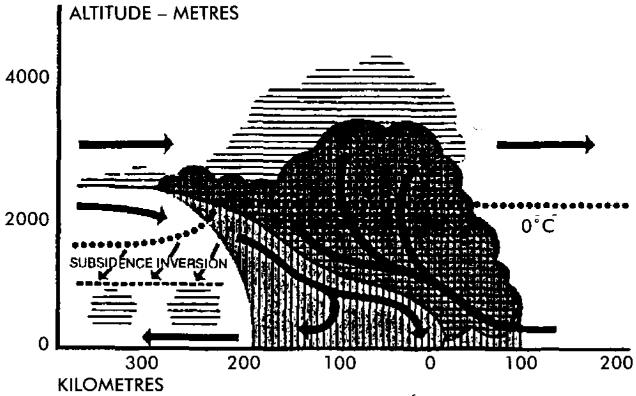
A front starts as a fairly straight line of demarcation between two different air masses. Very soon, though, our old friend coriolis gets to work and combines with the friction which inevitably exists between the two masses. The combination of these two forces twists the fronts into a characteristic pattern which is familiar to everyone who has seen a weather map. The main types of fronts are :-

**Warm front**, where warm air overtakes cold air. Warm air is less dense and therefore climbs up over the cold air when it meets it. The rate at which the warm air rises up the face of the cold air is very slow and for this reason the conditions found in the vicinity of a warm front are generally benign. They may be overcast and rainy, but they will not be violent. Warm fronts tend to take a long time to pass and they leave warm, moist air in their wake.



Diagrammatic cross-section of a typical warm front

**Cold front**. This results from cold air overtaking warm air. The denser cold air undercuts the warm air, forcing it upwards very rapidly. The conditions in a cold front are generally blustery with quite heavy rain and often thunderstorms. Cold fronts tend to pass fairly quickly and they leave cold and showery conditions in their wake, which usually clear very quickly to good unstable soaring conditions.



Diagrammatic cross-section of a typical cold front

Warm fronts are rare in mainland Australia. Maybe one or two will get to the southern coast of the mainland, although more than this may be experienced in Tasmania. The reason for this is that the fronts develop way to the south-west of Australia and the warm front (which is usually ahead of the cold front) has cleared to the south before the pressure pattern has moved close enough to influence our weather.

## HAZARDOUS WEATHER

There are several kinds of hazardous weather which can affect gliding operations, viz:-

### Strong winds.

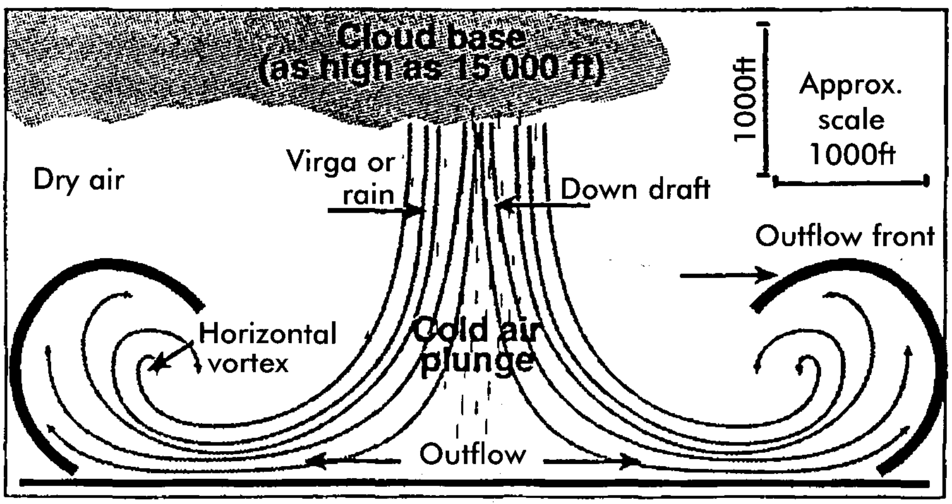
Although these are not usually hazardous to an airborne glider, they may be to a glider on the ground. Even an airborne glider is not completely immune to the effects of strong winds, as wind shear and wind gradient near the ground are known problem areas for glider pilots.

A glider on the ground is very vulnerable to the effects of strong winds. A typical training two-seater stalls at about 34 knots fully laden. At 35 knots it is flying quite well. Take away the weight of the two occupants (which constitute about 40% of the total weight of the glider) and its stall speed will be reduced to somewhere in the low 20s. With 25 knots of wind blowing over its wings, it will fly. An unattended glider in a strong wind is a firm candidate for being blown over unless it is properly secured. See Chapter 5.

### Thunderstorms.

These are obviously hazardous. Severe turbulence, extreme up and downdraughts, hail and lightning can all be deadly to a glider which gets caught under or near the edge of a thunderstorm. This is especially true in the tropics, where the vertical extent of such storms gives them a violence which can easily tear a glider apart.

There is one hazard associated with thunderstorms which may not be obvious. This is the "downburst" phenomenon (sometimes referred to as "microburst"), a rapidly descending tongue of cold air emanating from the edge of a fully-developed storm. Apart from the extreme rates of descent which exist in such downbursts, they have a dramatic effect on surface winds when they arrive on the ground. They can make their presence felt up to 8km from the edge of a large storm, in a position where a glider pilot could believe himself to be safe from serious effects of the storm. A glider trying to outrun the storm and make a precautionary outlanding would be seriously hazarded by the downburst and may find it impossible to control the glider in the extremely strong and turbulent wind near the ground.




**Microburst.**

The motto is - avoid large storms, not by a small margin of 2 km or so - give them a very wide berth indeed. There are forces at work well outside the immediate vicinity of these storms and those forces are invisible to the eye.

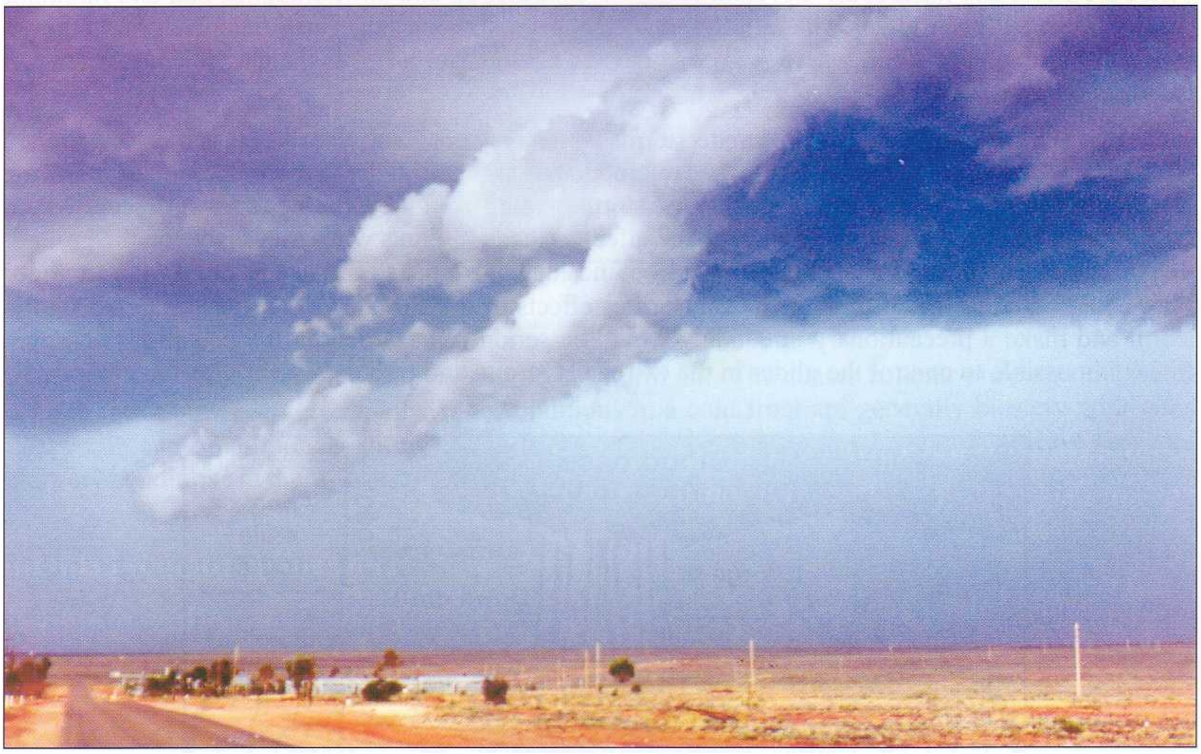
### Line squalls.

These can be described as miniature cold fronts of an extreme kind. Some of them give plenty of warning of their arrival, with cloud and rain heralding their approach. Others occur in clear air and the first hint of trouble is severe gusting of the wind, enough to overturn gliders and even tear them from their tie-down points.

Clear-air line squalls are fairly common in southern Australia and several gliders have been lost by being left out in the open instead of being hangared for the night. They seem to be exclusively a summer occurrence, related to instability and high temperatures. All that can be said about them is - expect the possibility of line squalls on very hot summer days if there has been very good lift around or you know (because of the forecast) that the air is very unstable.

### Hail.

This is usually associated with thunderstorms or at least with very large vertical development of clouds. Gliders or tugs left out in hail storms will definitely get damaged, perhaps beyond repair. If a hail storm or heavy shower is seen approaching, get the gliders and tugs under cover without delay. Light hail, up to about 5mm in diameter, usually appears as white streaks hanging down from the approaching clouds. Heavy hail, where the ice is glazed and the diameter can be up to golf-ball size, appear as green streaks from the clouds. On no account should any flying machine be left out in the path of such a storm. An airborne glider must obviously avoid such areas like the plague.



*A severe thunderstorm approaching Woomera, South Australia. The ragged grey-white pieces of cloud are known as a "roll cloud", as they rotate in a horizontal plane and indicate the presence of severe turbulence. The dark base of the storm can be seen and the haziness on the horizon indicates rising dust from the "storm front" striking the ground. This storm lasted for about two hours and produced much lightning, medium to heavy hail and wind gusts up to 60 knots.*

# CHAPTER 10 - BASIC SOARING TECHNIQUES

## THERMAL SOARING

### Thermal sources

Thermals form when a patch of ground becomes locally heated to a higher temperature than the general terrain. A number of factors govern whether a thermal is likely to form or not. These include the colour of the terrain, its composition, vegetation, moisture content and the angle at which the sun's rays strike the surface.

*Colour*

It is well-known that darker colours absorb more heat than lighter colours. Try this on a glider - feel the temperature of a white fibreglass wing and then feel the temperature of the darker red at the wingtip. There is an appreciable difference.

The same applies to the earth's surface. Dark earth colours absorb more heat and, by a process of conduction, spread this downward through the soil. Lighter colours absorb less heat and reflect more of it back to the atmosphere.

Insolation (solar energy) conducted into the soil may do some useful work for the farmer, but does not help the soaring pilot very much, as the surface does not get heated enough to form a thermal. On the other hand, insolation reflected back into the atmosphere is lost for ever.

Very dark surfaces, such as newly-ploughed paddocks, could therefore be a disappointment if they are relied upon to produce a thermal. So can very light surfaces, such as salt-pans. What is needed is a surface which will get hot enough to heat the air above it, neither conducting it away into the soil nor reflecting it back into the atmosphere.

All things considered, there are so many factors involved in the production of thermals that it is difficult to be hard and fast about it. The main thing is to be aware that different surfaces heat up at different rates and to be conscious of large contrasts in the patchwork of colours which make up the landscape.

*Composition*

There are many different surfaces which may affect the amount of local heating. Rock outcrops will heat up at a different rate from loose sand. Add this to the effect of the different colours and you can see that the picture is becoming quite complex.

Lakes are generally useless as thermal sources. They reflect most of the solar energy that hits them and, even in summer, remain quite cold.

*Vegetation*

Cereal crops, very common in Australia, are generally quite good from the point of view of thermal production. They do not reflect too much insolation and they do not result in much conduction of heat away from the surface. If the crop is reasonably long, it can trap heated air for long enough to form a thermal bubble, which only needs a trigger (such as a light breeze) to cause a bubble to leave the ground.

Trees use up much of the solar energy given to them. In the case of a large group of trees, the sun's energy is largely absorbed by the trees themselves, much of this energy never reaching the ground. The solar energy entrapped by the trees is used mainly to evaporate from the leaves much of the moisture which the tree has absorbed from the ground. This process is known as evapo-transpiration.

However, although forested area are generally not good thermal sources in the early part of the day, they can often be relied upon later in the day to provide quite large areas of gentle lift.

*Moisture content*

If there is large moisture content in the soil, much of the sun's energy will be used in evaporating this. Little or none may be left over to heat the surface itself. This accounts for why irrigation areas are quite rightly regarded as "sink-holes" for glider pilots.

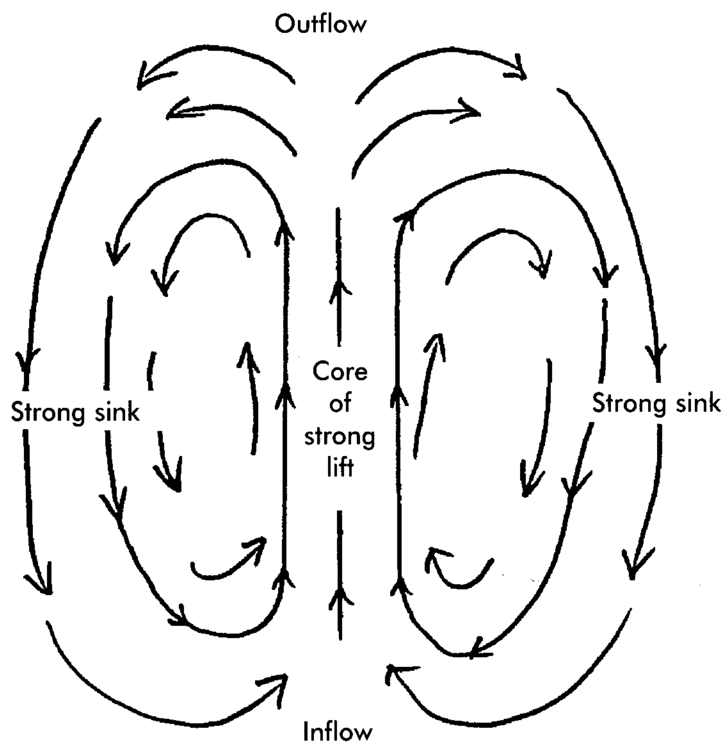
*The angle at which the sun's rays strike the ground*

The shallower the angle at which insolation strikes the ground, the less heating effect it will have. Hills and slopes facing the sun will usually produce local hot-spots, creating useful thermal sources. It is even better if the sun-facing slope is sheltered from any cooling wind which might be blowing - the so-called "wind-shadow" effect.

## Thermal shapes and lift distribution

Thermals come in all shapes and sizes and it is impossible to generalise. The late "Wally" Wallington, probably the finest of all soaring meteorologists, said that thermals are as varied as trees around the world, no two are exactly alike and no particular specimen can be described as typical of all the others (Meteorology for Glider Pilots).

However, thanks to research, we know enough about them to have a general idea of their shape and characteristics. It is generally agreed that a thermal, once it has broken free of the ground and more or less organised itself, forms itself into a "vortex ring". This resembles a smoke-ring, which can occasionally be seen from a cigarette, or in a more extreme form, a nuclear explosion. From the soaring point of view, the important feature of a vortex ring is that the central core of the rising ring ascends at a greater rate than the ring as a whole. The diagram below gives a rough idea.




This vertical circulation of a doughnut-shaped vortex ring accounts for why thermals have "cores" which give much better climb rates at the centre than they do at the edges.

Because of the vortex ring nature of thermals, a glider may experience a good rate of climb when it is well-established in the core, about half-way up the "doughnut", but another glider joining the thermal a few hundred feet underneath may only find weak and scrappy lift, or may find nothing at all. This is a common experience for all glider pilots.

The fact that the best climb-rate will be found in the core, weakening outside the core and eventually turning into strong sink just outside the thermal, means that a pilot must learn the skill of turning quite steeply in order to get the best out of each thermal. Thermal turns typically use 40 degrees of bank or more and it is fair to say that most pilots in the early stages of learning to soar are reluctant to use more than about 20 degrees of bank. Make sure you get plenty of instruction in steeper turns, stressing accuracy of flying and keeping everything under close control, including of course the airspeed and control coordination. It is in nobody's interest to have you losing control and spinning down on top of another glider a couple of hundred feet below.

## Locating a thermal

If cumulus clouds are present, locating thermals is not difficult. Each cumulus is fed by its own thermal and you just have to head off underneath the cloud to find it. However, you could still get caught. The life cycle of a typical fair-weather cumulus cloud is quite short, probably less than twenty minutes, so it is quite possible that by the time you get there, the thermal that originally formed the cloud has long gone. This can leave you with a feeling of considerable disappointment.

The trick is to decide which of the clouds you can see in the sky are growing, which have stagnated and which are dying. It is difficult to put this into words, but probably the closest one can get is to say that growing clouds have a well-defined base and hard, well-formed edges. Dying clouds are much more ragged in appearance, both at their bases and around the edges.

If you think picking the right cloud is a bit of a lottery, try finding a thermal in "blue" conditions; that is without any cloud. Australia being for the most part an arid country, most of our thermals do not contain enough moisture to condense out into cumulus clouds. Australian glider pilots must become adept at finding and using thermals without any beacons in the sky to guide them.

The simplest method is the so-called "forest theory". This says that, if you blindfold a man and let him wander in a forest, sooner or later he is bound to bump into a tree. A remarkable amount of thermal searching in blue conditions follows this random procedure. It is surprisingly successful.

Locating a thermal is partly a matter of seeking out likely sources, partly a matter of feel for the subtle changes which occur in the air as a thermal is approached. For instance, as the glider gets close to a thermal, there will be an increase in sink as it traverses the air immediately surrounding the vortex ring. This will then be followed by a noticeable "surge" under the glider, probably accompanied by an increase in airspeed as the glider encounters the horizontal gusts associated with the vertical gusts in the thermal. Some pilots also claim that they can see the horizon fall away in the canopy as the thermal is entered. If this works for you, use it. Finally, the variometer will confirm what the seat of your pants has been trying to tell you.

## Centring a thermal

Once a thermal has been found, the next thing is to decide which way to turn. There are two ways to approach this decision. You can either take pot luck and turn in any direction at random, on the basis that you can re-adjust when you know a bit more about the thermal. Or you can try to feel whether the main surge occurred under one wing rather than the other. If you can feel that the surge occurred under, say, the left wing, the thermal lies to the left side and you should turn in that direction.

Before going any further, this is a good opportunity to reinforce the need for good airmanship at all times, but especially when turning. When faced with the difficulties of thermal location and centring in the early stages, it is easy to forget that a good lookout is essential if you are not to become a menace to other airspace users. Never, never turn without "clearing your turn" first by means of keeping a good lookout.

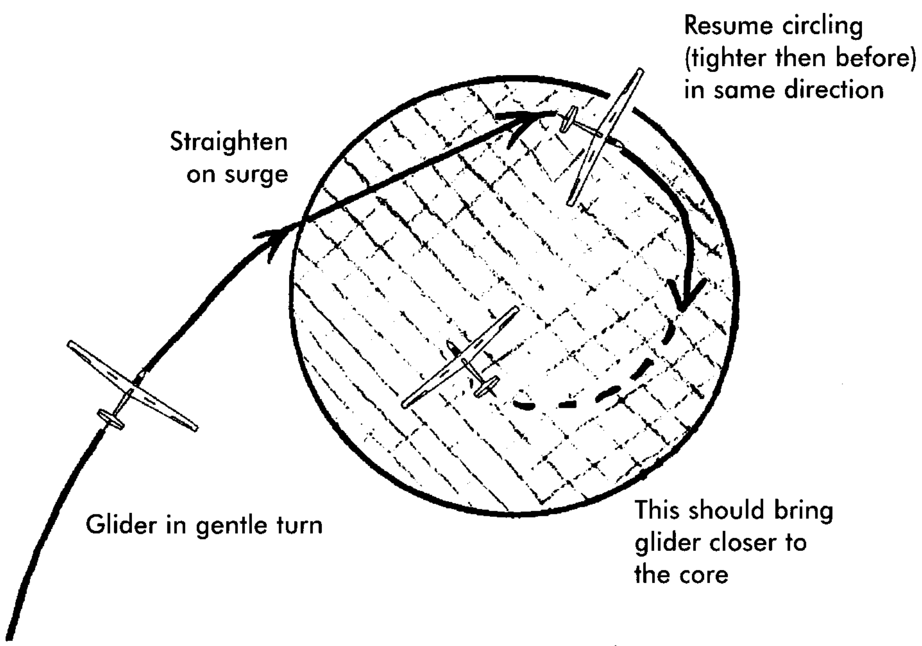
An audio device connected to or built into the variometer is a useful aid to keeping the head out of the cockpit during thermalling. Some may say it is essential and it is difficult to argue with this.

Now to locate the strongest part of the thermal, the so-called core. This is a process known as "centring" and is an important skill to acquire. A pilot who can locate a core quickly and circle the glider entirely within this core is destined to become a very efficient soaring pilot.

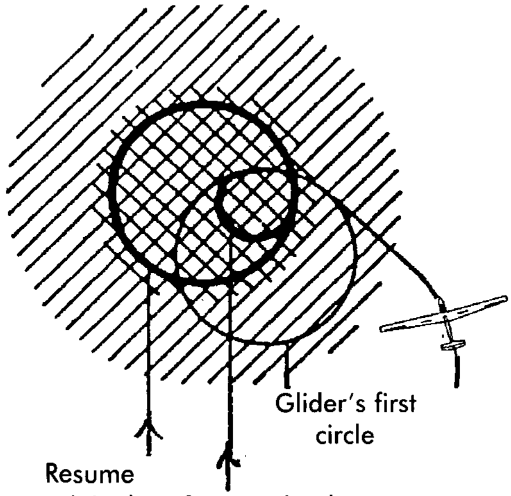
The first clue occurs at the moment you first encounter the thermal. If you feel that a wing is being lifted, but there is little or no corresponding lift indication on the variometer, you are well to the side of the core and you need to turn immediately toward the wing that was pushed up. Make a heading change of about 45 degrees, and then straighten out. If the variometer shows an increase in lift, maintain your new heading for about two seconds, then turn once again in the direction you were turning before. This should take you closer to the core and you should monitor the vario indication (but don't forget a careful lookout too - this is where the audio vario really comes into its own).

You may be lucky and find that this does in fact result in a good strong lift indication all round the circle. If it does, all well and good. If it doesn't, you have a choice.

One choice is to use the "straighten on the surge" method, where you simply straighten the glider when you feel the maximum surge, then resume the turn in the same direction after two or three seconds. This has the effect of shifting the glider towards the core. See below.




Another choice is the so-called "Huth" method, perfected by the famous German soaring pilot Heinz Huth in the 1950s. In this method, when the glider flies out of the thermal, keep circling until it comes back into the lift. At this point, after a pause of about a second, the bank is steepened and the rate of turn thus increased. Maintain this increased bank angle for not quite a complete circle, say about 300 degrees, then go back to the bank angle you had before. The diagram below illustrates the principle.




## Maximising rate of climb in a thermal

One of the most common questions asked by new soaring pilots is "how much bank should I use in a thermal"? Unfortunately there is no single answer to this riddle. It depends on a number of factors. About the only thing which can be said with certainty is that almost all pilots learning to soar use far too little bank and their climb rate suffers as a consequence.

Advocates of very steep bank angles claim that this is the only way to get into the real core of the thermal. Advocates of lesser bank angles reply that the greater sink rate of the glider at steep bank-angles negates any advantage that might be gained by banking steeply, and that a lesser bank angle is more efficient. Both are right.

The answer to the bank-angle question is that it depends on the thermal. If the core is strong and the thermal not very wide, the steeper bank angles undoubtedly work better. This is the situation which might exist in the lower levels of a thermal. Higher up, the thermal widens out and it may be better to ease off the bank angle a little and reduce the glider's sink rate.

The important thing is that there is no "standard" thermal, any more than there is a standard thermalling method. You must be prepared to use any or all techniques in search of the most efficient use of each thermal.

Finally, what speed to use? Theoretically the glider will lose the minimum amount of height at the speed for minimum sink rate. In level flight, this is about 7 knots above the stall speed. However, if the glider is banked, it will need an extra margin of speed because of the increased stalling speed in a turn, especially if you have chosen to use 40 degrees of bank or more. Furthermore, aileron control is often not very good at minimum sink speed and it is prudent to add a little to improve this. All things considered, unless the thermal is silky smooth (most are not), a reasonable speed to thermal a glider would be its maximum L/D speed, which is a little higher and a little less efficient than min sink speed in terms of sink rate, but gives a better margin of control and greater peace of mind.

## Losing a thermal

Thermals are lost for a number of reasons. The two most common reasons are (i) failure to fly the glider accurately enough, and (ii) the thermal distorting or bending during its climb.

*(i) Failure to fly accurately enough*

After a thermal has been found, accurate flying is needed to keep it. Variations in speed or bank-angle change the radius of turn of the glider and are a major cause of pilots losing thermals. Accurate control of attitude and maintaining a constant bank angle are the biggest contributions a pilot can make to keeping a thermal which has taken so much effort to find.

*(ii) Thermal changing its shape or bending as it climbs*

As a general rule, thermals expand as they climb. This may demand that the pilot changes the bank angle to stay in the best lift as height is gained. If you don't do this, the thermal may appear to peter out and, to all intents and purposes, has disappeared. In fact it is probably still there, but the pilot has lost it through failure to adapt to change as the thermal ascends.

Thermals may change their shape in other ways too. If the wind changes with height, which it usually does, it can cause thermals to "shear", that is to suddenly move off to one side. This occurs without warning and the pilot has to be alert for any sign of rapidly deteriorating lift, so that a decision can be made whether to carry out a search for the thermal or whether in fact you have reached the top.

There is another variation to consider. Thermals may have more than one core. In this case, if you manage to identify that such is the case, you will have to decide whether it is more profitable to try to centre on one strong core (which may be very narrow) or go from one core to another at a reduced bank angle, but still at an acceptable overall rate of climb.

## Re-locating a lost thermal

Many pilots give up the ghost when they lose a thermal. It may be of course that the thermal has stopped climbing or has petered out to virtually nothing. This can often be checked, either by noting the base of any clouds which may be present, or by observing the performance of other gliders in the vicinity. If there are others well above you, the chances are that the thermal is still there and you have lost it.

At the risk of stating the obvious, the first thing to do is to search for the lost thermal. On the assumption that it is a blue day and you have no clouds for guidance, this is best accomplished by firstly reducing your angle of bank, thereby increasing the radius of turn. It may be that the increased turn radius will take you back into lift at some part of the circle, whereupon you can re-centre on the core as per the "centring a thermal" section.

If this does not work, you have an awkward decision to make. Do you search upwind, downwind, crosswind or completely at random? Going downwind may work quite well, as the thermal may "bend" in a downwind direction due to an increase in wind-strength with height. Going downwind also has the advantage of higher groundspeed and thus greater chance of coverage of thermal-producing terrain.

On the other hand, there are some days when the wind decreases in strength with height. In this case, the thermals will appear to "bend" into wind and you will probably profit by searching in an into-wind direction.

### Selection of a "working height band".

This is a basic cross-country skill. Thermals seldom ascend at a constant rate over their entire height-span. Typically (if we can assume for a moment that there is such a thing as a "typical" thermal) the climb-rate might be a bit weak near the ground, strengthen to achieve a much better climb-rate as it gets higher, but then taper off to a lesser rate as it approaches temperature equilibrium with the surrounding air.

In their early days of using thermals, pilots naturally want to see how high they can get. They stay with the thermal until they reach the very top, even though the climb-rate tapers off to a pretty feeble rate in the last few hundred feet. They do this in every thermal they come across. This is not an economical way to use thermals for cross-country flying, and the pilot needs to acquire the knack of leaving the thermal when the rate of climb falls off to an uneconomical level, in order to maximise cross-country speed (and therefore distance covered).

In the same way, the pilot will notice that it may be a bit of a struggle to get started in the thermal, as thermals can often be weak and narrow low down. The pilot will apply this knowledge on any given day, by remembering that below, say 3,000 feet, thermals were broken and narrow, excellent between 3,000 and 6,000 feet and began weakening noticeably above 6,000 feet. This establishes a "working height band" for that sector of the cross-country flight of 3,000 to 6,000 feet.

The height band will not remain constant throughout the day, but will vary as the daily temperatures vary, probably reaching a peak of thermal strength in the mid-to late afternoon. The pilot must constantly assess the behaviour of each thermal in order to update the information to make the most efficient use of the thermals.

## HILL SOARING

### The mechanics of hill soaring

Hill soaring, otherwise known as ridge or slope soaring, is the simplest of all soaring techniques to understand and apply. However, like all skills, there are precautions to observe and specific techniques to understand.

Hill lift occurs when the wind blows toward a suitable hill. Some requirements are:-

1. A sensible minimum height for a suitable hill is at least 300 feet higher than the surrounding terrain. Even so, a pilot must be rated for outlandings before soaring on this kind of hill, because even a slight reduction in wind-strength may dump a glider very quickly and a landing quickly becomes necessary if this occurs. For operations on hills of this rather low height, the assumption is made that the glider takes off from a strip at the bottom of the hill on the windward side, or is approaching the hill from the windward side on a cross-country flight.

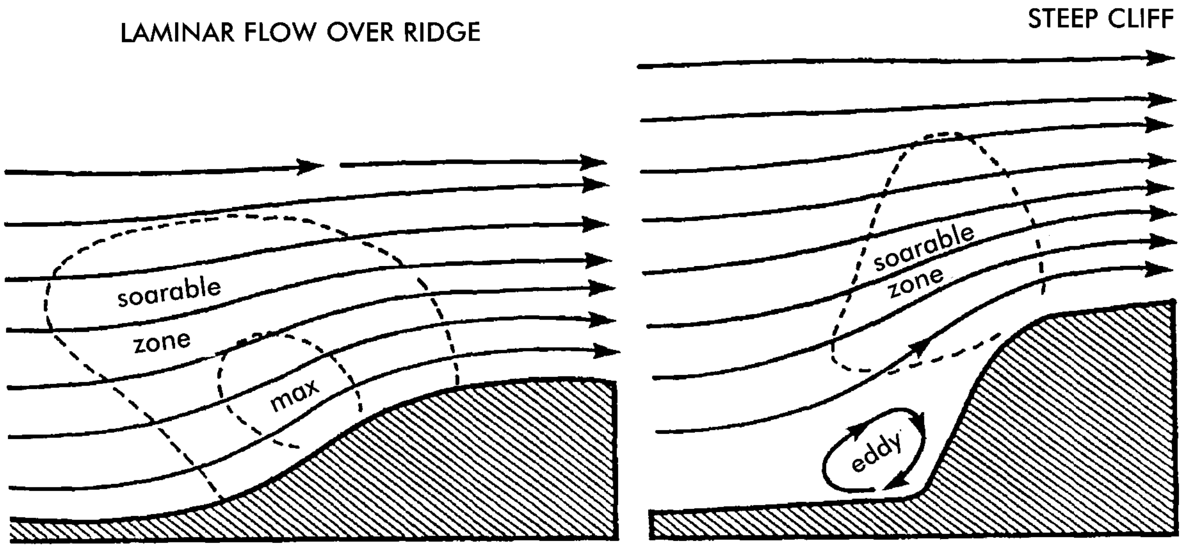
   If the glider is to be launched, and intends to land, on top of the hill, the hill should be at least double that height. Otherwise, the hill lift may not work to sufficient height to enable a circuit to be carried out for a safe landing on top.

2. Ideally the hill should slope at somewhere between 20 and 45 degrees. Shallower hills do work, but they are not as reliable and need more wind to produce a useable strength of lift. Steeper hills produce narrower updrafts and in some cases a vortex may form toward the bottom of the hill, effectively reversing the flow and causing trouble for a glider which gets low.

3. The wind should be blowing as close as possible to 90 degrees to the hill. Anything less than 90 degrees detracts from the strength of the hill lift.

4. The hill should not be too short. Anything less than about 2 kms in length may persuade the wind to blow around the ends rather than climb over the top. Even 2 kms may not be enough; some pilots discovered a few years ago that even Ayers Rock did not work in quite a brisk wind, probably because of this phenomenon.

5. Even though there is always some variation of wind with height, the mistake is sometimes made of launching a glider if there are signs of wind at the top of a hill, even though it may be calm in the valley. The hill will not produce lift under these circumstances - the wind must blow all the way from bottom to top.




*"OSTIV" diagrams*

## Where to find the best lift

If you get to the hill below hill-top height, you will need to go quite close to the hill in order to find lift, especially if the wind is not very strong. This sometimes means flying at only a wingspan away from the hill. This is a tricky business and should not be experimented with. Get some dual instruction from a competent hill-soaring instructor.

As height is gained, hill lift usually strengthens. If you are flying above the top of the hill, it will be advantageous to move away from the hill, into wind. When well clear of the hill, say as far above the hill as the hill is above the valley, the best lift will usually be found along a line approximately above the **bottom** of the hill.

## The effect of atmospheric stability on hill soaring

If the air is unstable, thermals will probably form and these will mingle with the hill lift to cause some interesting effects. In the case of flying into a thermal which is mixed with hill lift, the climb rate can become very high and it is important to exercise good airmanship in using such thermals. When you recognize that you have hit a thermal embedded in hill lift, if you are below or close to the top of the hill, it is not prudent to circle in the lift. Given the vagaries of **any** kind of lift, the thermal may let you down at the very moment you are pointing straight at the hill. It is best to carry out "S" turns in this kind of mixed lift, all turns being away from the hill, until you are well clear of the hill and circling becomes safe.

The mixing of the climbing part of a thermal with hill lift has the obvious effect of greatly increasing the total lift. What may not be so obvious is that the sinking part of a thermal can sometimes negate the hill lift, leaving the glider going nowhere fast, or even worse starting to sink toward the hill. Don't panic, concentrate on keeping a safe distance from the hill and either resume using hill lift a bit later or use the rising part of the thermal if you meet it.

Neutral stability usually gives the best and most predictable hill-soaring conditions. If conditions are very stable, it is possible that the air may get blocked and in extreme cases may flow horizontally along the slope instead of upwards.

When hill soaring, remember that there may be other gliders around, and you must accommodate them as well as yourself. This brings us to the special rules for hill soaring.

### Special rules for hill soaring

1. All turns must be outwards, i.e. away from the hill.

2. A glider overtaking another glider when hill soaring shall do so by passing between the overtaken glider and the hill.

3. If two gliders approach each other head-on while hill soaring, the glider which has the hill to its left shall give way by turning away from the hill.

4. When hill soaring, a glider shall not be flown lower than 100 feet above ground when within 100 metres horizontally of a person, dwelling or public road.

## WAVE SOARING

### The formation of lee standing waves

In the first chapter of this book, mention was made of a particularly smooth form of lift which was discovered, almost by accident, in the 1930s. This is the form of lift known to us as wave lift.

The waves form in the lee of a mountain range in certain wind conditions. The waves remain stationary with respect to the ground, the wind blowing through them. Hence the full title of "lee standing wave lift", usually abbreviated by glider pilots to just "wave lift".

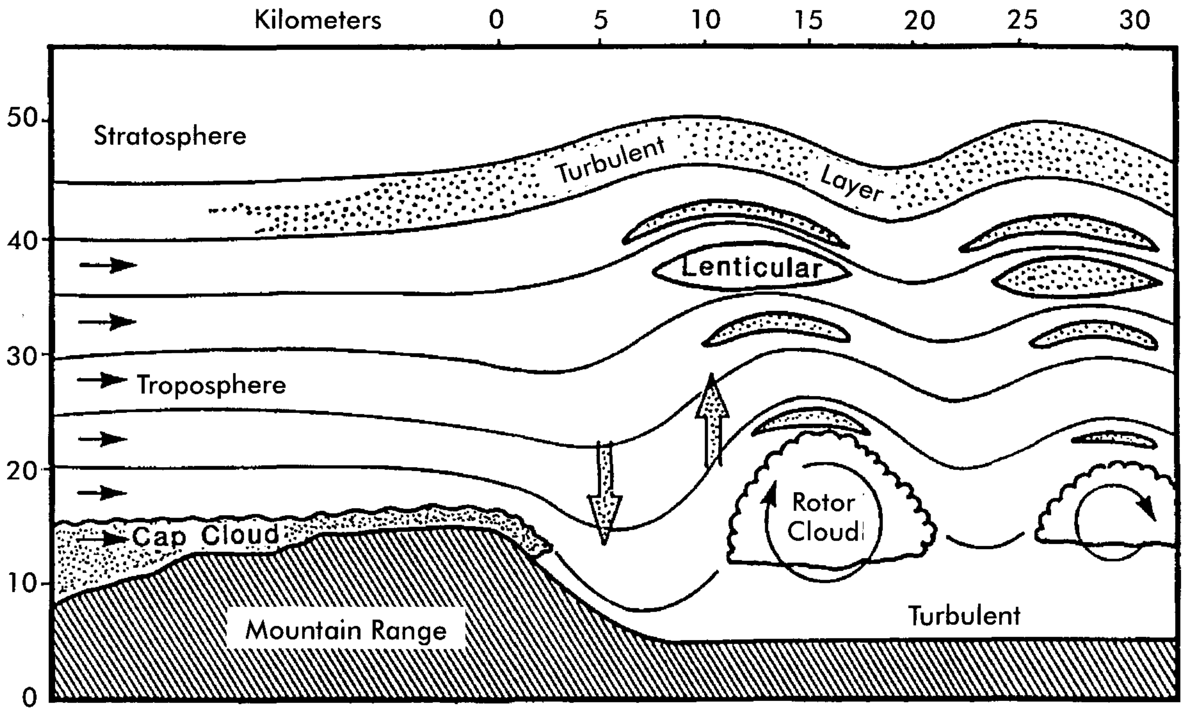
It is generally recognized that wave lift will form if the following conditions are met:-

1. The wind is blowing at close to 90 degrees to the mountain range.

2. The mountain range has a fairly steep windward slope and preferably a steeper leeward slope.

3. The wind increases in strength with height but maintains a fairly constant direction.

As might be appreciated, the complete set of conditions for the formation of lee standing waves is more complex than this rather simplified explanation, but it gives an idea of what is required.




*"OSTIV" diagram*

When waves form, they stream downwind of the mountains or hills which triggered them. The wavelength (distance between peaks) of the waves remains constant, whereas the amplitude decreases steadily until the wave system peters out some distance downwind of the hills.

## Use of wave lift

Wave lift differs in one important way from thermal and hill lift. Because wave lift can go to great heights (the Australian height record is over 34.000 feet and the world record over 48,000 feet), oxygen needs to be carried on virtually every wave flight. It goes without saying that pilots using oxygen equipment must be properly trained in its use.

Wave lift is not only useful for height gains, but can be used for cross-country flights. Distances of over 2,000 kms are now being flown in New Zealand and such flights are bound to become popular.

Mountain waves often produce visible proof of their existence in the form of characteristic "eyebrow" clouds, known as lenticulars (lens-shaped). These clouds are very smooth in their outline and do not drift with the wind, but remain stationary over the ground.

In the immediate lee of the mountain range, underneath the first of the lee waves, is an area known as the "rotor". It is well-named, as the air rotates rapidly in this area and produces severe turbulence. Gliders sometimes have to use the lift on the upgoing part of the rotor in order to gain access to the smooth wave lift on the windward side. It is a very rough ride indeed and there have been cases in the USA (none in Australia) of gliders breaking up in the rotor. It is usually, but not always, marked with a cloud, which is invariably ragged in appearance and visibly rotating like a giant ferris wheel. If you look closely, you might even spot the "Keep Out" sign pinned to it!

# CHAPTER 11 - PHYSIOLOGICAL FACTORS

## GENERAL

Gliding combines mental and physical activity which can take its toll on its participants. There are several aspects to consider.

## THE WEATHER

Gliding is dependent upon good weather for successful soaring. This often means hot days, usually with blue skies and intense sunlight. Gliding launch-points usually have little shade and people are exposed to these harsh conditions for many hours in a day. Not surprisingly, this has a detrimental effect on human performance.

Precautions need to be taken against the effects of heat and exposure to sunlight. These precautions are simple and it is foolish to ignore them.

## DEHYDRATION AND HEAT STRESS

It is impossible to drink too much water during a day's gliding. Most pilots drink far too little. Heavy sweating places very high demands on the body's fluid reserves. Sweat is over 99% water, most of the water being derived from blood plasma, which itself is 91% water. Therefore sweating reduces blood volume and causes dehydration. If fluid is not replaced, the body's core temperature may rise to a dangerously high level.

Insulated water containers are very cheap and a useful size for a day's gliding activities is 4 litres. Clubs can contribute to their pilots' well-being by providing a large (20 litre, say) water container at the launch point. It is a very good service to provide.

Plain water is best. If cordials or electrolytes (such as certain "sports" additives) are used, the solution should be weak, as heavier concentrations can inhibit the absorption of fluid into the body. Fizzy drinks are no use at all.

Take a small container of water into the air if you are going on a long flight. There are plenty of cheap plastic water bottles with built-in straws available nowadays and these are ideal for use in a cockpit.

If you are learning to fly or in the early stages of solo flying, and the Duty Instructor detects signs that you are suffering from dehydration, don't be surprised if it is suggested that you don't fly until you have taken in some fluid and allowed some time for it to take effect. Later on, when you have become more experienced, you will be expected to monitor this aspect of your activities yourself.

As a guide, the American College of Sports Medicine regards the Heat Stress Index (HSI) as a reliable measure of the environmental heat stress. The HSI is based on the wet-bulb temperature and a value of 28 degrees is considered the upper limit for strenuous exercise. There are plenty of days when the ambient temperature exceeds this figure on the average gliding field, and some of these fields are in humid parts of Australia. While it is not suggested that we put the gliders away on days over 30 degrees, it is prudent to pace yourself on the hotter days, so as to keep heat stress to a minimum.

An additional factor is acclimatisation. Repeated exposure to hot conditions results in the body progressively adapting to the new environment. However, this can take up to 10 days to be really effective. When acclimatised, the body sweats more readily and more copiously, leading to cooler skin and lower core body temperature when exercising.

People who work in an air-conditioned office five days a week, then go to the gliding club on a Saturday and work outside on a 30+ degree day will have no chance of acclimatising. Keep this in mind when rigging gliders and pushing them around the field.

## PROTECTION AGAINST THE SUN

Sun-tanned skin is damaged skin. It is well-known that exposure to sunlight can cause a wide range of problems, the mildest of which is a painful sunburn, the worst being skin cancer which can be fatal.

It is particularly important to protect the head and neck from the sun. To this end, a broad-brimmed hat is essential. Terry-towelling "floppy" hats are commonly worn and their only limitation is that the brim is usually not quite wide enough for protection of the neck. They should be worn in conjunction with a turned-up shirt collar.

Peaked caps with "foreign legion" flaps at the back, as commonly worn by Australian schoolchildren, offer good protection, but the peak tends to get in the way of turning the head in the cockpit. Thus they can save your skin on the ground, but create a real hazard in the air by inhibiting lookout.

"Akubra" type hats offer good sun protection, but most people find they are too hot to wear for long periods and they suffer from the same limitation as peaked caps when worn in a cockpit.

T-shirts lack neck protection and should not be worn for long periods in the sun unless accompanied by a suitable hat. The penalty is a seriously burnt neck. A conventional shirt, on which the collar can if necessary be turned up, is preferable.

Increasingly, pilots are turning to long-sleeved shirts for sun protection and long pants in preference to shorts for the same reason. Some pilots departing on long cross-country flights will be found wearing light cotton gloves of the kind which is obtainable from chemist's shops. These protect the vulnerable backs of the hands, which tend to roast under the canopy.

Sun-block cream or lotion is essential for a long day on the airfield. It is generally accepted nowadays that anything less than a 15+ sun protection factor is a waste of time.

# GLOSSARY OF TERMS

| | |
|---|---|
| AA | Airservices Australia. The regulatory body with responsibility for Air Traffic Services and aviation administration in Australia. |
| Accelerated flight | Flight in which the aircraft is accelerating around a curve, in other words a "G" loading of more than one is being applied. |
| AGL | Above ground level |
| AIP | Aeronautical Information Publication, the generic term for all the individual documents which provide pre-and in-flight information to licensed pilots. |
| AIC | Aeronautical Information Circular. A pamphlet-type notice, issued periodically to pilots, advising changes to facilities, procedures, etc |
| ASI | Air Speed Indicator, an instrument which measures the dynamic pressure caused by an aircraft's movement through the air, calibrated in knots. |
| Aspect ratio | The result of dividing the wing span by the average wing chord |
| AMSL | Above Mean Sea Level - self explanatory. |
| ATC | Air Traffic Control, the service responsible for the safe and orderly conduct of air traffic in controlled airspace. A division of Airservices Australia. |
| ADDGM | Aerodrome Diagrams. A document setting out the pattern of runways, taxiways and other features of Federal airports and Licensed aerodromes. Part of the En-Route Supplement, Australia (ERSA). |
| BASI | Bureau of Air Safety Investigation. A division of the Department of Transport and Communications, for the purpose of investigating accidents and incidents to all Australian-registered aircraft (including gliders). |
| BCAR | British Civil Airworthiness Requirements, a standard to which Australian gliders were constructed in past years. |
| Bernoulli's Theory | The Italian scientist Daniel Bernoulli established that if the velocity of a streamlined flow is increased, the pressure is decreased. This is how a wing works; the curved upper surface makes the air accelerate over the top of the wing, causing a reduction in pressure and tending to "suck" the wing upward. |
| Camber | The curvature of a surface, usually referring to the top surface of a wing. Analogous to the camber of a road surface. |
| CAR | Civil Aviation Regulation (previously ANR - Air Navigation Regulation). The CARs constitute the legal basis for the conduct of aviation in Australia. |
| CAO | Civil Aviation Order (previously ANO - Air Navigation Order). The CAOs are used to give effect to, or grant exemption from, the CARs. |
| CASA | Civil Aviation Safety Authority. The regulatory body with responsibility for controlling the standards and safety of aviation. |
| CFI | Chief Flying Instructor. The person in a club who is responsible to the club committee for the safe conduct of flying operations to GFA standards. |
| Chord | The distance between the leading and trailing edges of a flying surface such as a wing, tailplane, etc. |

| | |
|---|---|
| Cl | Lift Coefficient of an aerofoil section. |
| CIP | Chairman of Instructor Panel, the equivalent of a CFI in some clubs. |
| Cm | The pitching moment of an aerofoil. |
| C of A | Certificate of Airworthiness. A document specific to each individual aircraft on the Australian register, detailing its operating parameters and limitations. |
| C of G | Centre of Gravity. Usually written as CG. |
| CTAF | Common Traffic Advisory Frequency, the radio frequency used within a designated radius of nominated aerodromes. Not mandatory, non-radio aircraft may still operate within the designated radius. |
| DoTRS | Department of Transport and Regional Services. |
| ELB | Emergency Locator Beacon, a small transmitter carried in an aircraft which emits a distinctive tone when activated and allows the unit to be located by another aircraft. Also known as ELT (Emergency Locator Transmitter). |
| EPIRB | Electronic Position Indicating Radio Beacon, a marine locator beacon unit, cheaper than an ELB/ELT and suitable for glider use. |
| ERSA | En-Route Supplement, Australia. A document listing details of all Federal Airports and Public (Licensed) Aerodromes in Australia. Selected unlicensed aerodromes with significant traffic volumes are also included. Specific details of any gliding operations on these aerodromes are included. |
| FAI | Federation Aeronautique Internationale, the international governing body for sport aviation. |
| GFA | Gliding Federation of Australia |
| Glider | A fixed wing aerodyne without a power source (FAI definition). The term "sailplane" is regarded as interchangeable with glider. |
| ICAO | International Civil Aviation Organisation. |
| IGC | International Gliding Commission, the FAI sub-committee which deals with gliding matters at international level (formerly CIVV). |
| IH | Instructor's Handbook. |
| JAR 22 | Joint Airworthiness Requirements, Section 22, the standard to which modern gliders and powered sailplanes are constructed and certificated. |
| LAME | Licensed Aircraft Maintenance Engineer. A person licensed by CASA for the maintenance of Australian-registered powered aircraft. |
| Load factor | Definition of the load applied to an aircraft by the force of gravity. The load factor in normal flight is unity (i.e. 1G). Doubling the load factor results in 2G being applied to the aircraft. From the pilot's point of view, load factors are defined as positive G (upright flight) and negative G (inverted flight). |
| MBZ | Mandatory Broadcast Zone. An area surrounding designated aerodromes, within which radio communication is mandatory on specified frequencies. Non-radio aircraft (including gliders) are not permitted in this environment. |
| MR | Maintenance Release, the document (carried in each glider) which validates the glider's C of A on a year to year basis. |

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| MOSP | Manual of Standard Procedures |
| NGS | National Gliding School, the instructor and inspector training and standardisation school of the GFA. |
| NOTAM | Notice to Airmen |
| OCTA | Outside of Controlled Airspace |
| OSTIV | Organisation Scientifique et Technique Internationale du Vol a Voile, the international scientific and technical gliding organisation for gliding. |
| OSTIVAS | OSTIV Airworthiness Standards |
| PPL | Private Pilot's Licence |
| PAS | Power-assisted sailplane. A glider fitted with an auxiliary engine for self-retrieve. Not capable of taking off under its own power. Also known as "turbo" sailplane. |
| PS | Powered sailplane. A glider with an auxiliary engine, capable of self-launching. |
| QFE | The pressure-setting on an altimeter sub-scale which will result in the altimeter reading the glider's height above the point at which the setting was made, usually the aerodrome of departure. The initials are part of the international "Q" code and do not stand for anything in particular. |
| QNH | The pressure-setting on an altimeter sub-scale which will result in the altimeter reading the glider's altitude above mean sea-level. |
| QNE | The so-called standard pressure-setting on an altimeter sub-scale, which will result in the altimeter reading Flight Levels. Only used above 10,000ft. |
| RTO/OPS | Regional Technical Officer, Operations. The person responsible for the safe conduct of flying operations in a GFA Region. |
| RTO/A | Regional Technical Officer, Airworthiness. The person responsible for safe airworthiness practices in a GFA Region. |
| SAR | Search and Rescue |
| SARTIME | The nominated time of day after which various phases of SAR functions are declared, viz, uncertainty, alert, distress. |
| Sailplane | Theoretically a glider which is efficient enough to use atmospheric currents to gain height. In practice, the term "sailplane" is regarded as a normal term for any glider. |
| Soaring | The art of gaining height and/or prolonging a glider flight by means of natural currents in the atmosphere. |
| Span | The distance between the two tips of a flying surface such as a wing, etc. |
| Spar | The main load-carrying member of a wing or tail structure, running spanwise, usually at one-quarter to one-third chord. |
| Unaccelerated flight | Straight and level flight in which the load factor applied to an aircraft does not exceed the normal force of gravity. In other words, flight under "1G" conditions. |
| Venturi | A convergent-divergent duct, causing air flowing through it to accelerate through the constriction and lose pressure as a result. Used in gliders to compensate variometers for errors in lift/sink indications caused by changes in speed. |

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| VHF | Very High Frequency - radio frequencies in the range 30 Mhz to 200 Mhz |
| VFR | Visual Flight Rules, the rules governing the conduct of flight by visual reference, otherwise known as the "see and avoid" principle |
| VMC | Visual Meteorological Conditions, the conditions under which VFR flight is legally possible. Note: Gliders are only permitted to fly under VFR and in VMC. |

# GFA STANDARD COCKPIT CHECKS

## Pre take-off check - CHAOTIC

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| **C** | **CONTROLS**. Check for movement in the correct sense prior to entering cockpit. Ailerons and elevator must "move up to meet the stick". |
| **H** | **HARNESS**. Check for security, lap straps low on hips for both pilots. |
| **A** | **AIRBRAKES & FLAPS**. Check airbrakes for full and free movement, and then ensure they are closed and locked. Flaps set as required. |
| **O** | **OUTSIDE AND OPTIONS**. Check airspace and runway clear, wind direction and strength, adequate and competent ground crew available. Check options for launch failure on every flight. |
| **T** | **TRIM & BALLAST**. Trim set as required. Appropriate secure ballast as required. Tail dolly removed. |
| **I** | **INSTRUMENTS**. Altimeter set on QNH, ASI and other instruments reading normally, switches ON. Radio on if required. |
| **C** | **CANOPY, CARRIAGE, CONTROLS**. Canopy closed, locked and **clean**. Undercarriage locked down. Controls checked for full and free movement. |

## Pre-landing landing check - FUST

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| **F** | **FLAPS**. Set as required |
| **U** | **UNDERCARRIAGE**. Down and locked as placarded. |
| **S** | **SPEED**. Safe speed near the ground. |
| **T** | **TRIM**. Set as required for the selected speed. |

## Pre-stalling, spinning & aerobatic check - HASLL

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| **H** | **HEIGHT**. Sufficient for recovery by 1000ft AGL (2,000ft AGL within 2NM of a licensed aerodrome). |
| **A** | **AIRFRAME**. Flaps, airbrakes, undercarriage, set as required. Trim as required. |
| **S** | **SECURITY**. Harness tight. Loose objects stowed. |
| **L** | **LOCATION**. Clear of built-up areas, cloud, and controlled airspace. |
| **L** | **LOOKOUT**. Carry out 180 degree turn followed by a 90 degree turn in the other direction. (Do not carry out a 360 degree turn). Check in particular around and BELOW the glider. |

# "A" CERTIFICATE

## Requirements

1. Minimum age 15 years.
2. GFA Medical Declaration signed.
3. Minimum of 5 solo flights with normal landings.
4. Satisfactory check flight which must include the following as a minimum:
   a) An awareness of pre-spin symptoms and a demonstration of the correct action to prevent a spin developing;
   b) An accurate circuit without reference to the altimeter; and
   c) Correct handling of selected emergencies at the discretion of the checking instructor.
5. Oral examination on basic theory and, flight rules and procedures.

## Privileges and limitations

1. May only fly solo under the direct supervision of an instructor.
2. May carry out local soaring only.

# "B" CERTIFICATE

## Requirements

1. A total of 15 solo flights with normal landings, including at least one soaring flight of not less than 30 minutes duration. (Note: This means an overall total of 15 solo flights, not 15 solo flights since qualifying for the 'A')
2. Completion of the post-solo training syllabus in accordance with the Instructor's Handbook.
3. Oral examination on basic theory, flight rules and procedures (including the GFA Operations Regulations and Manual of Standard Procedures) and basic airworthiness.

   **Note:** Power pilots holding a student or higher licence may count 5 landings as pilot-in-command towards the "B" Certificate, but must meet the soaring requirement.

## Privileges and limitations

1. May carry out local soaring only.
2. May carry out mutual flying subject to the following conditions:
   a) The other occupant of the glider also holds a minimum of a 'B' Certificate.
   b) Each mutual flight is authorised by and carried out under the direct supervision of the Duty Instructor who shall nominate the command pilot for the flight. The command pilot shall carry out the take-off and landing.

# "C" CERTIFICATE

### Requirements

1. A total of 20 solo or mutual flights with normal landings, including two solo soaring flights of at least one hour's duration each. Trained and checked in ability to carry out a safe outlanding.
2. Received a "passenger awareness" briefing, using the section "Air Experience" in Part 2 of the Instructor's Handbook as a reference.
3. Oral examination on basic theory, basic navigation, basic meteorology, airways procedures, outlanding hazards, post outlanding actions and Search and Rescue requirements.
4. Satisfactory demonstration of spin entry and recovery.

### Notes on requirements

i) This means an overall total of 20 solos/mutuals;

ii) Only time in command of mutual flights counts towards a "C" Certificate;

iii) Power pilots holding a student or higher licence may count 10 powered landings as pilot-in-command towards a "C" Certificate, but must meet the soaring requirements.

### Privileges and limitations

1. May fly cross-country at the discretion of the CFI/CIP;
2. May carry private passengers (i.e. not for hire and reward and not introductory flights under GFA temporary membership) under the provisions of a Private Passenger rating as described in the GFA Operations Manual, MOSP Section 16.2.4.

# IMPORTANT NOTES ON THE BASIC PILOT CERTIFICATES

The operational functions of the GFA depend on a strong club-based structure. Each club has operational control over its members through the medium of its Operations or Instructor's Panel.

The certificates provide the certainty of proper follow-up training after initial solo. That is their primary function. They also provide the basic qualifications for mutual flying ("B" Certificate) and carriage of private passengers and/or cross-country flying ("C" Certificate). These privileges may only be exercised on any given day if the pilot is not only in current flying practice, but also meets the particular operational requirements of the club. Some clubs have special requirements, e.g. radio or controlled airspace procedures, and detailed periodic club requirements may vary from one club to another.

It is not expected that any club will unnecessarily stand in the way of a pilot exercising privileges that have been rightly earned. On the other hand, each club reserves the right to exercise operational control over its members and this applies to holders of these certificates, just as it does to all other club members regardless of status or experience.

# *Notes*