Australian Gliding Knowledge

5.3 2702219

Contents

Introduction

This book is written for people who want to learn how to fly gliders. It's also a useful source book for people who already know how to fly gliders and want to brush up on their knowledge. It's not intended to be a complete reference work, but it contains the essentials required to fly gliders well and to understand and enjoy the sport of soaring flight.

The book covers everything you will need during training, from the basic theory of how gliders fly to the meteorology which enables a glider to soar. It also covers most essential items in between, such as air legislation, basic navigation and use of radio. There's a section on Further Reading at the end of the book with a list of titles where you hopefully can find out the complete story.

You don't have to learn everything that's in this book to fly a glider… at least not right away. There are glider pilots who can happily float around the sky all day without knowing everything in this book, but it's fair to say that as sports go, gliding is quite technical and most good pilots do understand a great deal about the technical aspects of gliding.

The two most important things to remember as you are learning are; Stay Safe and Have Fun.

Stay Safe.

Though many of us feel as if we were born to fly, it's true to say that humans are not natural fliers in the way that birds are. So when we are learning how to fly, we need to learn safety habits which we will use throughout our flying lives.

Our senses are not as highly developed in many areas, especially sight, and if we want to fly safely, then we must train our senses to be the best they can be and to understand that we as humans, will always have limitations.

Have Fun.

Having fun is the whole point of it! There may be times during your early flying life that you find that you are not having fun. You may think that you will never get the hang of perfect landings (few of us really do) or that your training will go on forever. If you are feeling like that, don't panic! Almost everyone can be taught how to fly, but some of us take longer than others.

There are very few natural fliers and many people who take longer to learn in the first place, learn the lessons better and go on to become excellent pilots.

The Gliding Federation of Australia

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. The GFA is responsible for the establishment of pilot certificates which are highly regarded. CASA and the aviation industry accepts these certificates as the equivalent of a pilot's licence.

Gliding Certificates

As the basic building blocks of learning to fly gliders, the GFA has established three levels of pilot certificates, known as the A, B and C Certificates which lead up to the Glider Pilot Certificate or GPC.

The purpose of these levels is to progressively build up pilot ability and confidence, offering the developing pilot more privileges as their experience increases. These levels may be considered as basic certificates of competence and the loose equivalent of the 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 have a certain level of knowledge and teach unbreakable habits of safety before starting on goals such as the various international badges of achievement or becoming an proficient cross country or competitive glider pilot. The A, B and C Certificates help to cement the knowledge and safe habits in place so that you can move up to the final Glider Pilot Certificate.

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. Certificates are also aimed at helping these pilots achieve these aims.

Australian Gliding Clubs

In Australia, almost all glider training is done by clubs with highly experienced but volunteer instructors in club two seat gliders. In most cases, all the student pilot pays for, apart from the initial GFA and club membership, is for the launch and the glider time. In some 7 day a week club operations, there may be a small surcharge for instruction.

This is quite different to most other types of flying where training is done by commercial operations where the costs can be high. In a gliding club environment, the process of learning creates a team spirit which is almost entirely absent from powered flying. Club training keeps costs down and helps to make gliding one of the cheapest ways to fly.

There are clubs in almost all regions of Australia and they come in all shapes and sizes. Some are small weekend only clubs with a handful of members while others are busy 7 day a week operations with dozens of members. Most clubs own their own tug or winch or both and a fleet of gliders which are available for hire at very reasonable rates by club members.

However small the club, they usually have a lot of assets. These might include owning or leasing a large airstrip and most will have club houses, bunk rooms or other accommodation, hangars, workshops, flight centres, briefing rooms, tractors and mowers etc. It takes a lot of club members to get a glider into the air. Apart from the tug pilot or winch operator, there will be a duty instructor and normally someone to run the wing.

When you start learning to fly a glider, you will join the GFA and a local club, either as a short term member or if you are convinced that gliding is the sport for you, as a full member. From that time onwards, the gliding club is your club, and you are essentially heir to the rights and responsibilities of the club.

The saying goes, "gliding clubs are like banks, you can't make a withdrawal without making a deposit'. That's not entirely true, but the point is that your club needs you and your help to keep going and the more you put into your club, the more you will get out of it.

There are over 2,500 glider pilots in Australia, operating more than 1,000 gliders from over 60 clubs. The GFA trains all gliding instructors and airworthiness inspectors.

Most gliding clubs have a Student membership rate, available to all members who are under a certain age 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.

The minimum age for flying gliders solo in Australia is 15 years. The Civil Aviation Safety Authority recognises flight time as a pilot of a glider towards meeting the requirements for a power pilot's licence under CASR Part 61. A glider pilot who wants to learn to fly powered aircraft should enquire about this concession since it can save a lot of money.

The structure of this book

Most glider-pilot training is practical and "hands-on". In the early days, you'll either be in the air with an instructor or talking on the ground while getting the glider back to the launch point. However, there is some theoretical knowledge which is not only useful, but actually makes the task of learning to fly easier and more fun. You'll need to know this theoretical knowledge bit by bit as you learn to fly.

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

Australian Gliding Knowledge is divided up into sections which cover history, theory and practical information about gliding roughly in the order that you will need to read it. That is, the complexity increases as you get towards the end of the book. In most cases you can learn more about any particular section by looking at the book titles in the Further Reading section at the end.

Some sections are followed by a set of oral questions and answers which are relevant to your glider training and necessary to become a safe glider pilot and share the air with other formally trained pilots. You'll need to be able to answer these questions to pass the basic gliding certificates, but it's not too difficult in that the questions are all covered by this book and the answers are given on the pages following the questions.

Units of Measurement

Gliding in Australia uses a mixed set of units for measurement which can at first be confusing. In most cases there are sound reasons for using these units.

Speed is measured in knots, or nautical miles per hour. A nautical mile corresponds to a minute of arc on the earth's surface. So a degree of latitude, measured off the vertical scale on the side of a naval chart with a pair of dividers is exactly 60 nautical miles. Very convenient if you are navigating… at sea. A nautical mile = 1,852 metres. For a quick approximation, if you want to convert knots to kilometres an hour, just double the figure.

Distance on the ground is measured in both kilometres and nautical miles. Within the sport of gliding, kilometres are used for measuring tasks and records while nautical miles are used when gliders communicate with general aviation traffic.

Altitude is measured in feet. In fact, in commercial transport and general aviation, feet are used in almost every country in the world to measure altitude, Russia being one exception. However in many fields of sport aviation such as paragliding and gliding in Europe, height and speed are both measured in metric units.

1 foot = 304.8 mm.
1000 feet = 305 metres.

All instruments such as airspeed indicators and altimeters in Australian gliders are marked in knots and feet. It's not too difficult to get your head around most of this, but it's very important that you are flying in another country, you double check the markings on instruments, especially the air speed indicator.

Gliding, the real flying sport

The sport of gliding is a little like surfing… an exhilarating free ride but where you can't see the wave or the sea.

It's like chess… a technical mind game where you can't see the pieces. It's like white water rafting…except that the ride is up and downhill and can go on for hours.

The air is a vast ocean which covers the earth and like any ocean, the air is constantly in motion and has waves, currents, ripples and whirlpools. But you can't see air in the way you can see water unless there's a cloud to give you a clue. That's what makes gliding such a fascinating and involving sport.

There's a beauty and mystery about gliding which is missing in many sports and though gliding has challenges, competitions, races and records, it can be enjoyed every bit as much by people who have no interest in competition and are looking for a purely personal challenge or a way to experience the real beauty, freedom and spirituality of quiet flight.

The very first form of flying was gliding. There are a lot of claimants for who first "conquered the air" and you can read about them in the history section at the end of this book, but whether you think it was Otto Lilienthal, the Wright Brothers or even Sir George Cayley, it was gliding which came first.

Gliders only go downhill. Like any aircraft when you turn the motor off, gliders generate the lift to stay airborne by moving forwards and downwards under the influence of gravity. We'll get to the details of that later, but for gliders, it is all downhill and initially these early pioneering glider flights were short and measured in seconds.

In an effort to stay up for longer, misguided aviators soon moved to heavy aircraft with noisy motors and forgot about gliding. Not for long though because even Orville Wright went back to the sand dunes of Kittyhawk in 1911 and set a record for unpowered flight which was not broken for many years.

It was the Germans who returned to gliding as a sport in the 1920s and it was not long before they discovered that there are plenty of places where the air is going up very much faster than the glider is going down and if the glider remains in this up-moving air, or at least avoids the sinking air, a glider may stay up for ages.

How long? Well, long enough that this sort of record hunting was banned. Duration records became dangerous when pilots trying to break the record fell asleep at the wheel. Let's leave it at that gliders can stay up for days. Nowadays there are plenty of other more interesting records to break.

There's a record for height gained in this up-moving air. At the moment this stands at over 70,000' and is likely to go a lot higher. There's a record for the maximum distance flown between first and last light which is over 3,000 km and dozens of records for speed over a set course and distance. If you are interested in breaking one yourself, do a search on the FAI gliding commission website for details.

There is not much practical use in gliding other than the fact that glider pilots are pioneers in the exploration of the energy in the atmosphere. However you look at them, gliders are not a very useful form of transport. Which is a good thing because it leaves gliders and gliding to be what it is good at. The best form of sport flying, and excellent fun.

Gliders and sailplanes, gliding and soaring

Back when gliding began, with Otto Lilienthal probably, all a glider did was slowly sink to the ground. Some gliders stayed up for a while when flown like kites and briefly in 1911, Orville Wright ridge soared over the dunes at Kittyhawk for just under 10 minutes. The wind speed for this flight was estimated at 50 miles per hour at which speed even a brick might be expected to soar! So for a long time, when you strapped yourself in to a glider, you had a good expectation of being on the ground very shortly after takeoff.

So it must have been with some surprise that the early fliers at the Wasserkuppe in Germany did not quietly glide to the ground, but instead began to climb above the hill and remain airborne for minutes and then hours. Probably with some pride, instead of calling them hanggleiters or literally "slope gliders" they started calling their aircraft segelflugzeug or sailplane, and what they did was no longer referred to as gliding but soaring.

When another low-cost do-it-yourself gliding movement started up on the slopes in the mid '60s, the pilots hung from their aircraft and controlled them with weight shift… and were duly called hang gliders. When they left the slopes and started going up in thermals a few years later, the name remained.

For most people, a sailplane is a glider and there are probably few members of the public who understand or care about the distinction between gliders and sailplanes… so here, we refer to them just as gliders.

These days, there are many types of gliders from foot-launched flex wings to relatively high performance rigid flying wings to paragliders which blur all these distinctions and many of these pilots move to sailplanes at one time or another. Each type of glider has its attractions… some can be stuffed into a bag, others will fold up into a tube and a half dozen of them fit on the roof of a car… which a sailplane will not.

However, what a sailplane does well, none of these other forms of glider can do anything like as well. And that is fly efficiently, further, faster, higher and longer. That's not for everyone… one hang glider pilot, after doing brilliantly in sailplanes, gave it up because "it was too easy."

If you are a pilot who is coming from another form of gliding, welcome! Sailplanes don't offer the same wind-in-your face experience but they do offer performance measurable in hours, kilometres and thousands of feet and an active, friendly, and safe club environment in which to enjoy this wonderful sport.

Getting Airborne

The Bungee launch.

The “classic” way of getting a glider into the air, (that is the way they did it in the old days) is the Bungee launch. A gang of people would hang off a long rubber rope formed into a vee and with a glider hooked on at the sharp end, would run down a hill, normally until they fell into a heap on the ground.

Depending on the hill, the wind on the slope and the glider the pilot would get as many people as he needed to catapult the glider into the air, normally three to six people a side. Huge fun probably, and hugely labour intensive.

You can still get a bungee launch at a few sites overseas. It’s possible on a perfect site to do a Clayton’s bungee launch by just rolling the glider down the hill until it has enough speed to fly.

Bungee launching was not suitable for people wanting to go gliding on flat sites and soon alternative and less labour intensive methods of launching were worked out.

Aerotow launching.

Aerotow launching is the most common method of getting a glider into the air in Australia. The glider is connected to a light aircraft by a length of rope and towed into the air.

Tug aircraft are normally general aviation light aircraft fitted with a suitable tow hook and release for the tow rope. Crop dusters are common as tugs in Australia.

Aerotowing is a reliable way to get airborne because the glider can be towed to a good height and often the glider can release right into a thermal.

There are drawbacks to aerotowing. It’s expensive compared with other methods of getting airborne because the tug aircraft is expensive to buy, expensive to maintain and fuel costs increase every year. The time between launches is also quite long because it takes time for the tug to descend ready for another tow.

Winch launching.

Winch launching is a relatively low cost and rapid way to get a glider into the air. The winch consists of a big drum wound with a winch cable of rope or wire, driven by a powerful motor. The opposite end of the winch cable is attached to the glider and when the signal is given, the winch operator winds in the rope at a speed suitable for the glider on tow.

Launches are rapid and gliders can climb to over 1600' in under a minute. The basic costs are low. The winch does not cost as much as a tug to build or maintain and the fuel used may be under three litres per launch.

The winch cable, normally made from high tensile steel spring wire (piano wire), Spectra, Dyneema or polypropylene rope, has a long service life. Modern winches are using Dyneema rope which is stronger and lighter than polypropylene and allows higher tows. The time between launches can be as low as 5 minutes with a properly run operation.

There are a few more drawbacks with winching than aerotowing. The launch height is not as high and gliders may not find a thermal before they need to land. Winch launching is more labour intensive than aerotowing because there needs to be an extra person to run the winch cable back to the launch point and overall, winch launches are not quite as reliable as aerotows.

All this tends to be outweighed, especially for training and circuits, by the speed and low costs involved with winch launching.

Car Towing.

Car towing is a simple and cheap method of launching gliders. A tow rope of about 500 metres is hooked onto a car or ute at one end and onto the glider at the other end and as the car accelerates, the glider climbs, much as with a winch launch. When the glider releases, the car returns to start the process again. An alternative and successful technique is to pass the tow rope around a pulley at the end of the strip so that the car drives towards the glider and, at least on the low part of the tow, the driver is able to watch the glider.

The drawbacks of car towing is that the strip has to be fairly long, normally over 1600 metres, and smooth. In dry areas of Australia at a busy club, it could be imagined that a strip might soon be turned into a dustbowl.

Self Launching and Touring Motor Gliders.

Gliders can be fitted with motors and though this may offend the purists, it has been the dream of many glider pilots since the 1930's in Germany. Right now, almost all new gliders can be fitted with a motor at the time of purchase or at some later stage. There are two main types of gliders with motors. Self Launching Gliders (SLG) and Touring Motor Gliders (TMG).

SLGs are fitted with a small motor which is mounted in the fuselage, normally just behind the wings. In most variants, the motor is fitted with a pylon mounted propellor which pivots up into the airstream and folds back again inside the fuselage when not required.

The motor is covered by well-fitting doors so from a distance, one might not know there was a motor fitted at all. Currently, most SLGs have 2 stroke motors, though both electric and jet engines are available in some types of glider.

TMGs are built like a conventional lightweight sports aircraft with 4 stroke engines, feathering props, carburettor heating and fixed undercarriages.

Most SLGs are not designed for cruising under power. The engine and propellor are optimised for take-off and climbing so the most efficient way to use the engine is in what's called Saw-tooth mode, where the glider climbs a few thousand feet, and then the engine is folded away and the aircraft glides. In most cases, running the engine in an SLG is a noisy process whereas the 4 stroke engines in TMGs are very quiet and suitable for cruising under power.

TMGs are designed to perform well enough with the engine turned off that they can function as gliders. When operating as a glider, the propellor blades are feathered to reduce drag. The gliding performance of most TMGs is close to that of a two seat trainer which makes them a very useful aircraft when training.

Early on in the training process, using TMGs to do circuit planning can be very efficient. The motor is only used for take-off and handled by

the instructor and as soon as the aircraft is at circuit height, the motor is turned off and the student takes over.

It is fairly easy to do 6 circuits in 30 minutes with a TMG and almost impossible any other way. TMGs are also good for out-landing training where a lot of field selection and circuit planning can be taught without actually landing.

Sustainers

There is another type of glider, fitted with a less powerful engine called a sustainer. These gliders do not have enough power to self launch and the motor is only designed to get the glider home at the end of a day's soaring if the lift runs out. Again, sustainer motors are available as electric, jet or two stroke.

Statistically, 2 stroke sustainer motors are not as reliable as those fitted to self launchers. Petrol powered sustainers don't have an electric starter so they can only be started by diving the glider until the propellor spins. They cannot be started on the ground like an SLG motor for pre-flight inspection or maintenance. For that reason, sustainer motors don't get run as often as a self launcher's motor and they may only get used a handful of times a year.

The idea of an SLG is very attractive… they offer a large degree of freedom because the pilot can launch single handed and operate out of airports with powered aircraft as well as having superior get-you-home capabilities compared with sustainers.

SLGs can fly to where the lift is and increase the soaring opportunities of the pilot and have a good chance of getting home again at the end of the day and there is no doubt that pilots with a motor tucked away behind them have less worries about out-landing and can fly more adventurously.

However there are a lot of potential drawbacks with SLGs. They are complex machines both mechanically and operationally. Almost all gliders fitted with 2 stroke motors which as the manufacturers warn, do not have the same reliability as a 4 stroke and should not be relied upon to fly over un-landable areas.

When flying cross country, glider pilots who get low will have a landing paddock or strip selected by 2000' AGL and be setting up a circuit by 1000'. When winch launching, most pilots will expect to get a thermal off the average 1600' launch.

However, pilots who fly SLGs are recommended to start thinking about an in-air restart at 2000' and have the engine out and ready to start by 1500' above ground at the absolute minimum. This means in effect, that the pilot of the SLG is giving up the idea of soaring at the same height that most winch launched pilots are just starting.

Pilots of SLGs have a lot more to think about when taking off under their own power than aerotowing and there's a busy period while turning off the motor and retracting it where the pilot must maintain a safe and effective lookout while completing the motor shut down procedures.

When attempting an in-flight restart, the motor may fail to start. The mechanism to extend and retract the motor can fail to operate. When the motor is fully extended, the glider ratio of an SLG is similar to that of a hang glider… the glider loses height very fast and the landing approach is similar to an approach with almost full airbrakes on.

And of course most SLGs carry a tank-full of 2 stroke fuel. Which is inflammable. Reading the section in an SLG flight manual on engine fires can make even the brave feel nervous!

There's one more issue to consider. Most modern sailplanes have an airframe life of at least 12,000 hours and there are plenty of gliders over 40 years old which have flown only a third of those hours. In the case of most SLGs, in 40 years time, the airframe will still have lots of life, but its 40 year old engine will be an antique!

This is a problem for 2 stroke engines but is likely to be much more of one for the current batch of gliders fitted with electric or jet engines where getting batteries and electronics to fit them in 40 years time may be a nightmare.

All that being said, there's no doubt that SLGs are increasingly the glider of choice for those who can afford one.

Instructors

In Australia, most if not all instructors who teach gliding are unpaid. They do it for their club and to give something back to the sport they love. This makes learning to glide very much cheaper than other forms of flying because the student pays for the launch and the glider hire and little else.

Instructors sit in the back seat of gliders for hour after hour in the hot sun enduring frightening takeoffs, bad landings and uncoordinated flying without complaint. Since all instructors teach from the same manual, they have a consistent approach not only to flying but to communicating technique to you, the student.

Well, most of the above is true. However, instructors are human and they surely must get tired and grumpy and as disillusioned as their students do at times! Not all instructors are born communicators and at times, the trainee pilot must interpret commands like "left wing down" as not meaning "put the left wing down" but "the left wing IS down, lift it up!"

A student pilot can often prefer one instructor and be reluctant to try others when their preferred instructor is not rostered. In fact, you can learn something from every instructor and it is worth flying whenever you get the chance.

If you build a good relationship and have a lot of time with one instructor, they will probably be the best assessor of your progress while if you fly with many instructors, it may take a flight or two for each to discover your abilities.

And if you find that a particular instructor doesn't suit you, then by all means look for another. Here, the bigger gliding clubs have a distinct advantage because there are more instructors.

Going solo

Most of us see going solo as being the biggest step in our gliding training and are desperate to be allowed to go solo. We may feel ready and think our instructor is holding us back. Some instructors are more cautious than others and they don't want to take risks with you or the glider so be patient. It's OK to take a little longer and what you learn in the meantime will stand you in good stead later on.

Just because we have gone solo does not mean and end to training. There's a lot more to learn! That being said, going solo is an important step though your first flight in a single seater, your first five hours or your first big cross country can be more memorable occasions.

Most people will take at least 40 flights to get to a solo standard though people with experience in power aircraft and young people can sometimes get to solo standard in less flights.

There's no doubt that you'll learn faster if you have an intensive training period… a week full time is better than a string of weekends. It's also better to choose a gliding club for your initial training which is surrounded by lots of suitable outlanding fields even though this may not be your intended home club. You'll go solo earlier and be more experienced when you do return to your home club.

Age

You can learn gliding at almost any age and there are glider pilots from 14 (in some countries) to well over 80, but it is a fact that young people learn a lot faster than older ones. However, older people normally have a lot more time to spend gliding and less commitments to prevent them flying. These days, many people starting gliding are well over 50. If this is you, then don't despair if you see teenagers going solo while you are still circuit bashing. You'll get there in the end and no doubt remember the lessons better!

Gliding needs you!

Yes it does. It is essential to get new people into any sport and gliding is no exception. If you want to learn to glide, gliding clubs and instructors will do their best to make this happen.

Air sickness

It's fairly common for people to feel uneasy or a little airsick on their first flights in a glider. Sometimes this is caused by the small cockpit, sometimes by unfamiliar turbulence or by banking steeply in turns.

In almost all cases, it is something you get over in a short while. The trouble is that most experienced pilots and many instructors will forget that low-airtime students can get airsick and fly a little too exuberantly… as the students themselves will in time.

If you find that you are feeling airsick or you don't like the bumps or steeply banked turns, tell the instructor right away.

You might fly the glider straight and level for a while until you get over the feeling or you might decide to schedule flights for earlier or later in the day when the air is calmer until you get used to the many new sensations.

Experienced pilots can get airsick too. Often this happens on the first flight after an absence. It also happens when you're feeling a little under the weather or tired. If you want to get the most out of your flying, don't fly unless you're feeling good about it.

The Government and Gliding

This book is intended to help people who want to learn how to fly gliders get airborne. Within a few months of starting, you could be the pilot of a single seat glider sailing from cloud to cloud in the endless playground in the sky.

But there are other people up there with you. Not just glider pilots. There are passenger transport aircraft, jet airliners, commuter aircraft, helicopters, Santa Claus, UFOs, hang gliders, ultralights, drones and radio controlled models. The only way that you can relax in your glider is by understanding the privileges, rights and responsibilities of being a pilot.

Gliding is both a recreational activity and a competitive air sport. The day to day rules of gliding are simple and easy to follow, but the freedom which they give us were hard fought by the early pioneers of the sport.

In some countries the government regulates the flying, and the sporting aspects are administered by the national gliding association. In Australia, the national body is both the Regulator (in conjunction with CASA) and a sporting administrator.

The Gliding Federation of Australia, or GFA, exists as a "self-administrating" body. This means that it works together with the Civil Aviation Safety Authority (CASA) to set rules and regulations and oversee gliding operations in Australia. It also administers the sporting aspects, including representation on the International Gliding Committee and facilitating local and international competitions.

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.

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 and 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 a CASA document called a Civil Aviation Order (CAO).

The GFA has two specific CAOs allocated to it to spell out all these 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.

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 the GFA and glider pilots operate. In the day to day operation of gliders and gliding clubs, the CASA "stamp of approval" on our Operational

Regulations is not a burden.

GFA standards are set and maintained by people who are passionate about gliding and experienced pilots and instructors. The GFA consultative process is followed whenever changes to operational procedures or standards are needed. 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 founding of the GFA in 1949.

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 documents mentioned above are combined into one consolidated GFA Operations Manual and all sections are available from the GFA website as downloadable files, as are all other GFA operational manuals, forms and documents.

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 necessary buffer placed between outright Government control of the sport and the clubs and people engaged in gliding activities.

Learning to Fly Gliders

The process of learning to fly gliders is broken down into several stages… and don't worry, very little of it is classroom stuff, almost all training is practical.

The first stage in learning to fly gliders is pre-solo training. This takes you to the point where you fly safely enough to be allowed to take up a glider and fly it by yourself. At that point, if conditions are right, you'll be sent off on your first solo flight or two.

This is normally followed by a few more consolidating training flights and then after five solo flights and a short online exam, you get your A certificate.

The GFA's Glider Pilot Training Record is used by instructors to log the stages your proficiency as well as being a useful airfield reference. Gliding certificates and badges are awarded to signify stages of achievement. In almost all cases, these certificates and badges have been around since the start of the sport of gliding and are internationally recognised.

Depending on how fast you learn, you can be up to solo stage after a week's training. If you can only fly on the weekend, it will probably take longer than a week. Either way, take your time and be prepared for the shock of not being a natural pilot. Few of us are!

The next stage is the B certificate. Training now concentrates on reinforcing skills already learned during pre-solo training. Two seater training is interspersed with solo flying.

When you have a total of 15 solo flights, you can take a short online exam and apply for your B certificate.

Once you have your B certificate, you should be able to fly well and training for the C certificate concentrates on getting pilots ready for passenger carrying, cross country flight and the possibility of outlandings. A total of 20 solo flights is required for the C certificate.

Recently, the ICAO compliant GPC or Glider Pilot Certificate was introduced to cap off training. The GPC can be directly converted to an internationally recognised CASA issued Glider Pilot Licence.

The sport of gliding is about having fun and is relatively free of licences, exams and certificates. When you have your GPC, you can fly locally or cross country, carry passengers and fly with few restrictions.

So why would you want any more training, coaching or qualifications?

The answer is, to make you into a complete, confident and happier pilot. Boating around in the sky in a glider can be a hugely relaxing way to spend an afternoon but there is more to gliding that local soaring.

Power pilots can get bored with circuits and many look for further training challenges, such as instrument flight ratings. Similarly in gliding, low-airtime pilots can get frustrated by the way some pilots can stay away all day, flying hundreds of kilometres, while they are back on the ground in half an hour.

Cross country skills can be learned and pilots can improve their technique to the point where they are both competent and successful pilots, able to operate independently of club instructors.

The more successful you are in achieving your own goals, the happier you are going to be as a glider pilot… the more you'll get out of the sport and the more you will put into it in return.

Pre-solo Training

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

A few gliders and quite a number of powered Touring Motor Gliders, have side-by-side seating, for example the Grob 109 and Scheibe Motor Falke. In these aircraft, the controls are duplicated, but instruments are shared. Side by side seating can be an advantage at some stages of training because communication is easier between pilot and instructor.

Many people learning to fly gliders have some flying experience, either in powered aircraft or in hang gliders or paragliders and training is adjusted to suit experience.

Most people start with what's called an Air Experience Flight. This is a chance for you to see if you like gliding. Be warned though! Some of us take a few days to become comfortable with being in a sailplane and if you are sure you want to be a glider pilot, then it may be best to skip this flight, bite the bullet and start proper training right away.

The pre-solo training syllabus.

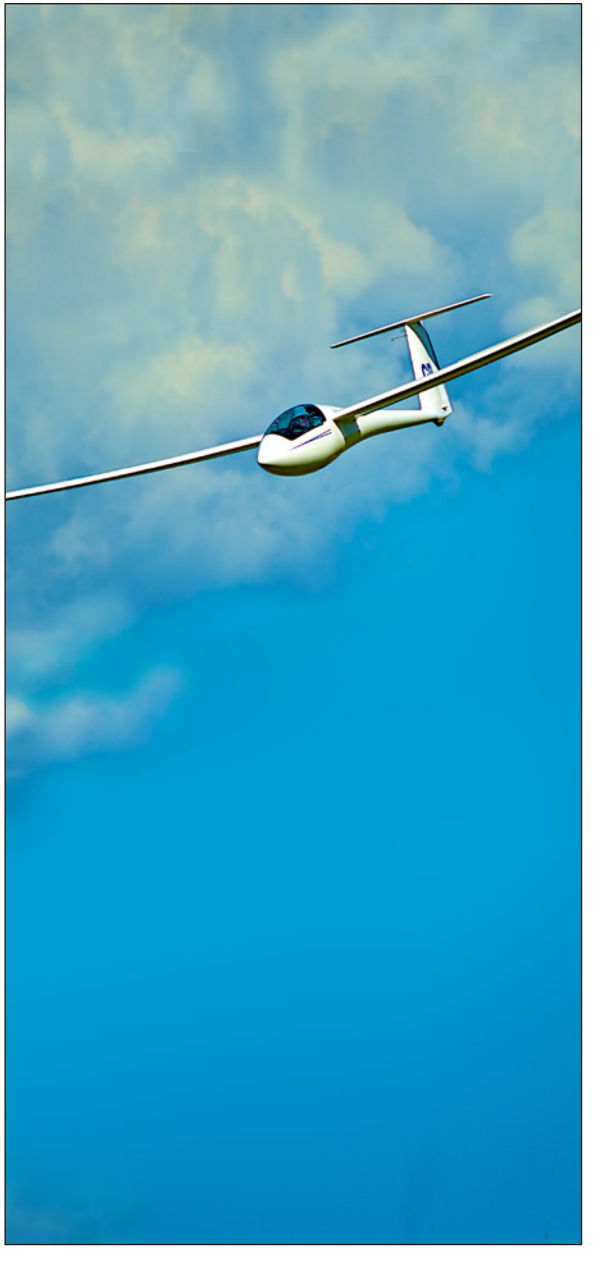
- Orientation flights stress the third dimension and introduce the different sights and sounds to someone who has very likely spent their life on the ground.
- Lookout awareness. Look and see. The limitations of human vision.
- Ground handling of the glider, launch procedure and signals.
- Orientation in flight and sailplane stability.
- Pre-take-off checks. ABCD and CHAOTIC.
- Primary effects of controls and the effects of banking.
- Aileron drag and rudder co-ordination.
- Sustained turning flight and the effects of all controls.
- Lookout procedures in turning and level flight
- Straight flight at various speeds and trimming the glider.
- Pre-landing checks.
- Slow flight and stalling. Never low and slow.
- Launch and release procedures.
- Radio and FLARM use.
- Take-off.
- Circuit joining and planning.
- Thermalling and thermal centring techniques
- Thermal entry.
- Soaring with other gliders.
- Landing approach and landing.
- Spinning.
- Crosswind take-offs and landings.
- Launch emergencies.
- Flying with other gliders and aircraft.
- Rules of the air.
- Human factors.
- Threat and error management.
- First solo flight.

Post-solo Training

Post-solo training revises and builds on skills you have already learned to enable you to become an independently proficient glider pilot able to safely enjoy the many challenges, excitement and pure pleasures of soaring flight. In most clubs, training in two seaters progresses from basic training aircraft to higher performance two seaters and conversion to single seat gliders.

The post-solo training syllabus

- Side slipping.
- Steep turns.
- Thermal sources and thermal selection.
- B Certificate
- Outlanding. Field selection and outlanding procedures.
- Flight preparation, glider, trailer and pilot.
- Soaring instruments and flight computers.
- Meteorology and flight planning.
- Navigation, charts and airspace.
- Cruising, speed to fly and height bands.
- Demonstrated cross-country capability.
- Passenger carrying.
- C Certificate.
- DI Certificate.
- Independent operator Level 1.
- Glider Pilot Certificate.



Gliding Certificates

The A Certificate

These are the requirements for being awarded an A Certificate:

- Minimum age 15 years.
- GFA Radiotelephone Operator Authorisation (FROL).
- A minimum of 5 solo flights with normal landings.
- A satisfactory check flight, which must include the following :
- An awareness of pre-spin symptoms and a demonstration of the correct action to prevent a spin developing.
- An accurate circuit without reference to altimeter.
- Correct handling of selected emergencies.
- Online examination on basic theory and flight rules and procedures by a Level 1 or higher Instructor.

Privileges and limitations

- May only fly solo under the direct supervision of a Level 2 or higher rated instructor.
- May carry out local soaring only.

The B Certificate

These are the requirements for being awarded a B Certificate:

- A Certificate
- 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" Certificate).
- Satisfactory completion of Sections 1 to 29 of the GPC training syllabus.
- Online examination on basic theory, flight rules and procedures and basic airworthiness by a Level 1 or higher Instructor.
- Note: Pilots holding a CASA issued Student or higher licence or a 'High Performance Endorsed' Pilot Certificate issued by RAAus may count 5 powered landings as pilot-in- command towards the B Certificate, but must meet the soaring requirements.

Privileges and limitations

- May only fly solo under the direct supervision of a Level 2 or higher rated instructor.
- May carry out local soaring only.
- May carry out mutual flying, subject to the following conditions:
- The other occupant of the glider also holds a minimum of a "B" Certificate.
- Each mutual flight is authorised by and carried out under the direct supervision of a Level 2 or higher rated Instructor, who must nominate the command pilot for the flight.

The C Certificate

These are the requirements for being awarded a C Certificate:

- A total of 20 solo or 'in command' mutual flights, including two solo soaring flights of at least one hour's duration each.
- Trained and checked in ability to carry out a safe outlanding.
- Received a passenger awareness briefing using the "Air Experience" section in Part 2 of the Instructor's Handbook as a reference.
- Online examination on basic theory, navigation, meteorology, airways procedures, outlanding hazards, post-outlanding actions, and SAR requirements by a Level 1 or higher Instructor.
- A satisfactory demonstration of spin entry and recovery.
- Note: Pilots holding a CASA issued Student or higher licence or a 'High Performance Endorsed' Pilot Certificate issued by RAAus may count 10 powered landings as pilot-in- command towards the "C" Certificate, but must meet the soaring requirements.

Privileges and limitations

- May fly cross-country at the discretion of the CFI.
- May carry private passengers (i.e. not for hire or reward and not Air Experience Flights), at the discretion of the CFI and duty instructor.

GFA Glider Pilot Certificate

The Glider Pilot Certificate (GPC) is awarded to pilots in recognition that they have been trained and assessed as competent to operate a sailplane as an independently proficient GFA soaring pilot following satisfactory completion of the GPC Training Syllabus.

The GPC Training Syllabus includes meeting the requirements for the issue of a Level 1 'restricted' independent operator endorsement as detailed in Section 13.1 of the GFA Manual of Standard Procedures, Part 2.

All pilots operating under GFA are subject to GFA Operational requirements. The GPC recognises that the pilot has been trained and tested to the full extent of the GPC training syllabus and is therefore entitled to be approved to operate a glider within the privileges and limitations of the syllabus items as notified by pilot logbook endorsements.

The GPC training syllabus may be found in the Operational Regulations at Appendix 3 and a copy is to be printed and attached inside the cover of the Pilot's Log Book.

Theory

When learning how to fly a glider, it is not necessary to learn more than the fundamentals of the theory of flight and how gliders fly. However as you progress, you'll probably realise that you want to know much more about this fascinating subject… endlessly fascinating in fact, because there never seems to be a limit to the number of different theories about how lift is created over an aircraft's wing!

The theory which follows should be enough to cover the basics but you should understand there's a lot more to it than is presented here. There's a section at the end of this book with suggestions for further reading on everything from glider and aerofoil design to books on being a better pilot.

Glider design and construction

One thing is apparent when looking at a group of modern gliders lined up ready to launch and that is they all look much the same. In fact it can take a long time to learn how to tell one type from another because the differences may be very slight.

The reason for this is simple. Gliders are designed to be as efficient as possible in the air while retaining the practical ability to operate as a piece of sporting equipment… being able to land in rough paddocks and being easy to pull apart and fit in trailers.

The need for utility has ensured that gliders almost all operate in more or less the same way… which is generally a good thing. Most modern gliders can be put together and dis-assembled quickly and safely in more or less the same way. Controls hook up and disconnect in similar ways, mostly automatically as wings and tailplanes are assembled with the fuselage.

Over the years, the search for more and more efficiency has refined the shape of gliders until they're almost identical in appearance.

With competitions, wind tunnel research and computer programs to optimise airflow, glider designers have got to the point where the differences in performance between top gliders in the same class are measured in fractions of a percent. There may be more difference between gliders of the same type than between gliders of different types in the same class.

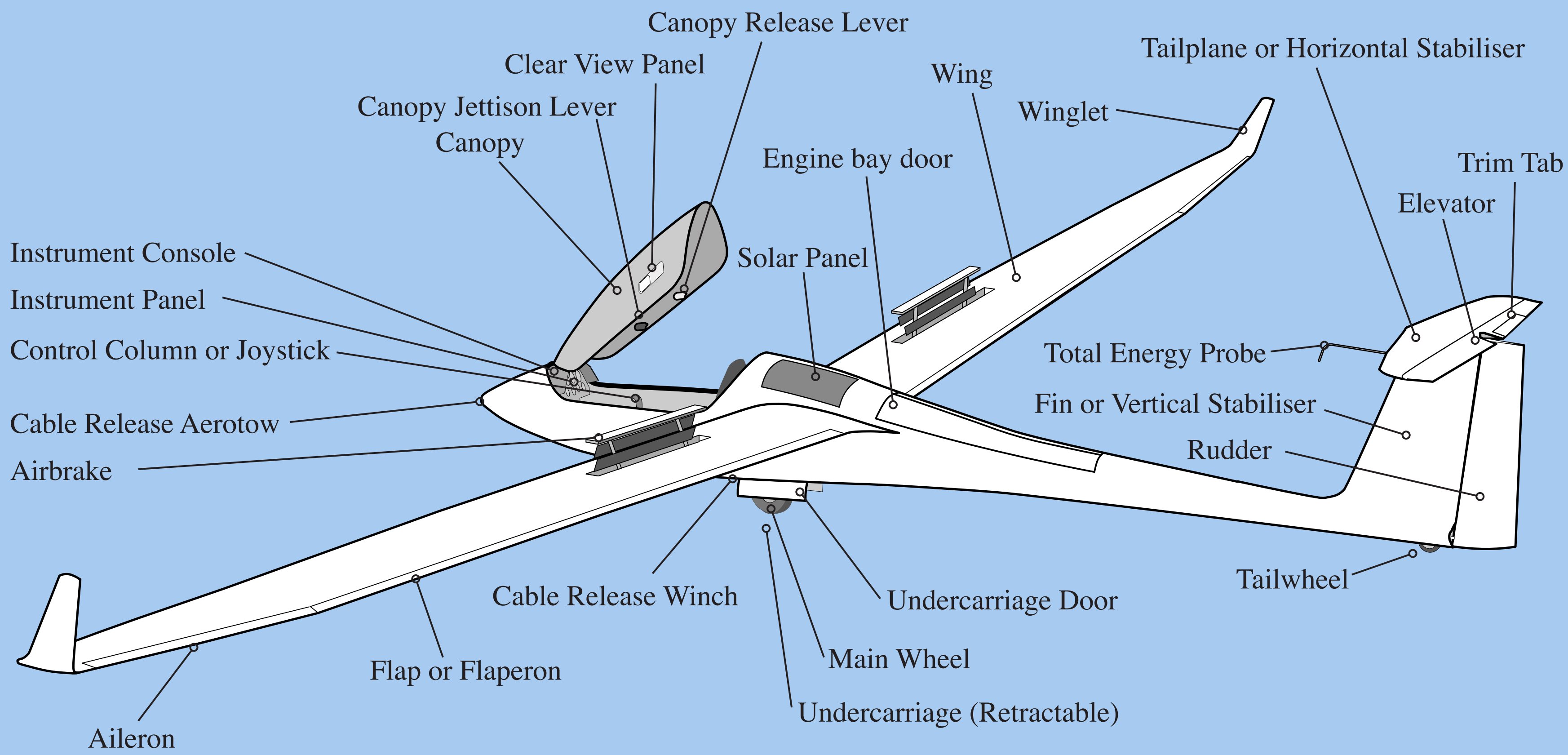
For those reasons, you can be confident that the theory behind the way gliders fly is shared with all gliders and all aircraft.

Gliding terminology.

If you have ever learned how to sail, you'll probably be relieved to find that there are not dozens of new and strange words to learn when starting gliding.

Most of the words used in gliding are in common usage, unlike many sailing terms which have been worn down over hundreds of years of use. You will need to learn the terminology of gliding as you go along so you can understand your instructor and not the least, so you can take part in arguments with friends after flying!

Naming of Parts

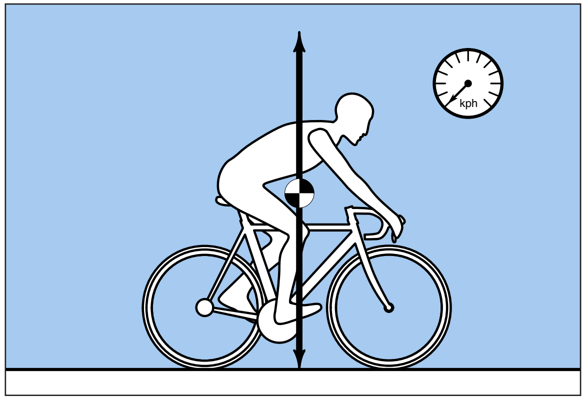


This illustration shows the principal components of a modern sailplane. Not every sailplane has all these parts. For example, some sailplanes are not fitted with two cable release hooks. Some gliders have flaps and some of these are connected as flaperons. Training gliders normally have a fixed undercarriage and a nose wheel or skid. Most modern gliders are able to fit a sustainer or self-launching motor, but these are not always installed.

Aerodynamics

There's no magic about how a glider flies. It is basic Newtonian physics… the stuff you learned at high school and possibly hoped you would never have to use again. To learn to fly a glider, you don't need to understand all of this… but it certainly helps.

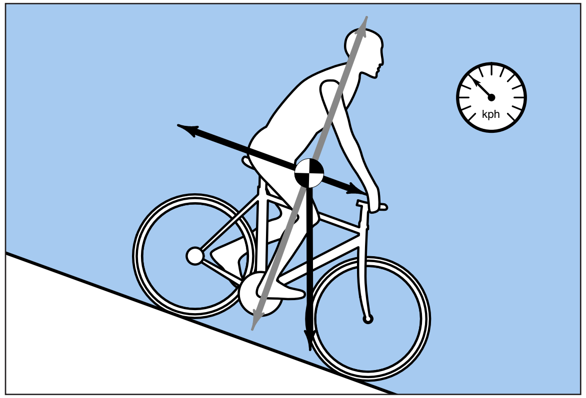
To begin with, lets look at just the basic forces acting on a more or less 2D vehicle which we all understand… a bicycle. At rest, the bicycle is acted on by the force of gravity. The weight of the bike presses into the ground, and the ground in turn reacts against this force and pushes upwards by an equal amount. It's obviously equal, or the bike would either sink into the road, or float above it.



Kinetic energy is the energy in an object due to motion and because the bike and rider are stationary, it has no kinetic energy.

Potential energy is the energy in an object because of its position or attitude. If the bike is stationary and on flat ground, it does not have much potential energy… only as much as would be realised if it fell over sideways.

Now look at the forces acting on a bicycle and rider freewheeling at a steady speed down a long slope.

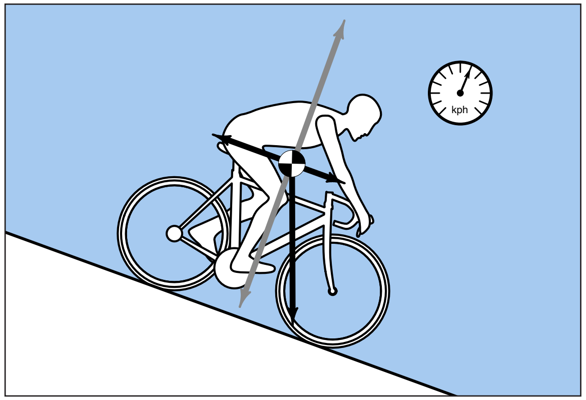


The bike and rider combination now has both kinetic energy due to the downhill motion and potential energy because the bike is not yet at the base of the slope

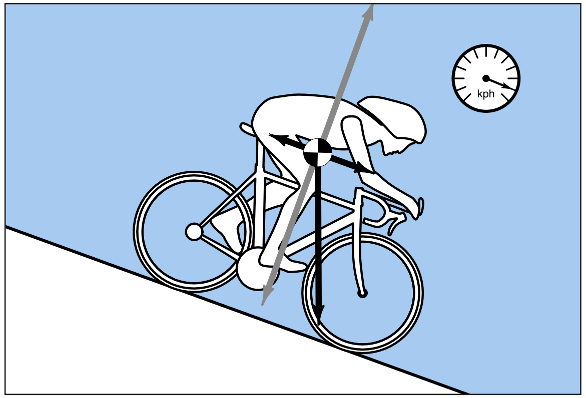
The force of gravity can be split into two components. The force keeping the bike on the ground, and the force pulling the bike down the slope. There's another force called Drag which is opposing the force of gravity pulling the bike down the slope. Drag is the wind resistance caused by air friction and turbulence around the moving bike and rider.

At a steady speed the drag force is exactly equal to the gravity component pulling the bike down the slope.

There's little that the cyclist can do about gravity and weight, but the cyclist can easily affect drag. By crouching down or by sitting upright, the cyclist can change the amount of drag.



This will cause the bike to accelerate or decelerate to a new speed where drag once again equally opposes the force of gravity pulling the bike down the hill, and a steady speed or equilibrium of forces is regained.



Drag is essentially kinetic energy lost to the cyclist and transferred to air turbulence. Drag increases with speed, cross sectional area and surface roughness. So a crouching cyclist in lycra with a streamlined helmet should have less drag than an upright commuter and lose less kinetic energy as a result.

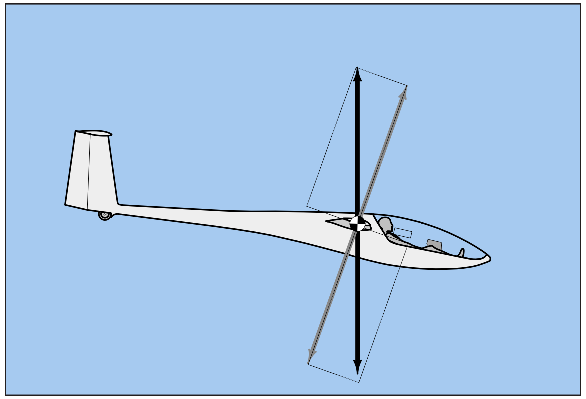
When the slope ends, and the bike and rider reach the flat, the bike will slow to a stop. The potential and kinetic energy which the bike had, is now used up, converted to some other form of energy by drag.

It's said that bicycle racing is an exercise in energy management and drag reduction. So is gliding.

Lift and Drag

When a glider flies at a steady speed through still air it is descending on a shallow slope, just like our bicycle. It has the same basic forces acting on it. Lift acting at right angles to the direction of flight, gravity acting downwards and drag acting against the direction of flight. The glider has an amount of kinetic and potential energy due to its height, speed and mass.

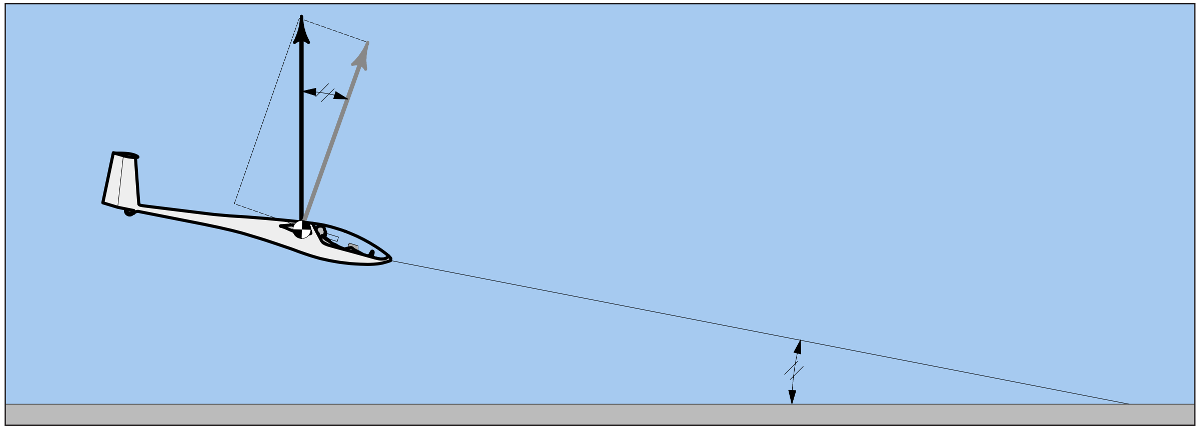
The glider's wings produce an upwards force (lift) which equally opposes the force of gravity and supports the entire weight of the glider. As with the bicycle, the force of gravity gives the glider its forward motion down the slope and drag opposes this. The drag force exactly opposes this downhill component of gravity or the speed of the glider would change.



If the pilot finds a source of lift and is able to climb, the glider's potential energy is increased. If the glider continues to descend, eventually it will reach the ground and land. The potential energy gained during the launch and thermals is all used up.

Gliding is a game of energy management; making the most efficient use of the available energy.

Now here is a very interesting thing. Remember the comment earlier, about how gliders were designed to be very efficient? There's an easy way to measure this efficiency as one might measure the efficiency of a car by the amount of fuel it used per kilometre.



Lift/drag ratio or L/D

A glider's efficiency is measured by the ratio of the lift generated by the wings to the drag created by the aircraft. And if this ratio is drawn, it is the same as the glide angle. In the drawing, the drag force has been exaggerated. In most gliders, when operating at their most efficient speed, the drag is *at most, 30 times smaller than lift*. And if it was drawn to scale, the slope or glide angle would less than 2°.

When pilots discuss the efficiency of a glider, they refer to the "Ell-Dee" or L/D which means the lift/drag ratio. A training aircraft will have an L/D of about 30:1. Most club gliders will have an L/D of between 40:1 and 50:1 and the best open-class gliders may be in the region of 65:1.

What this means practically is that a training glider with an L/D of 30 a 1000 metres above the ground, can expect to fly 30 x 1000 metres or 30 kilometres before reaching the ground… approximately 10 km per 1000' of height. This makes understanding L/D a practical tool for everyday flying.

A slightly surprising thing about L/D is how little the "D" is. A typical two seat training glider with pilot and instructor aboard will weigh around 500 kgs. Its wings will generate this much force in level flight. If this training glider has an L/D of 30:1, the drag on the glider is 500/30 = 16. That is, just 16 kilograms of drag.

So when a sailplane like this is being towed in level flight by a tug, the force on the tow rope is only 16 kilograms. Very small.

Best L/D

Best L/D is the airspeed at which a glider will fly the longest distance for the least height lost. The best L/D for a glider occurs at one speed only which happens to be the speed for minimum drag. You can find out this speed from the handling notes or flight manual for the glider. It's normally quoted in this form: Best Glide Ratio = 38:1 @ 52 knots.

You fly at the speed for best L/D when you want to stretch out the distance that you can fly.

L/D = Airspeed/Sink Rate
Lift/Drag
Distance Flown/Height Lost
Weight/Drag

Minimum Sink or Min. Sink

There's another key speed for gliders and that is the minimum sink speed (commonly called 'min. sink'. This is the airspeed at which the glider's sink rate is at its minimum and it is normally about 7 knots above the stall speed. Either side of this speed, the sink rate increases. Min. sink is normally quoted in the form: Min. Sink Rate: 125 feet per minute @ 43 knots. The min. sink rate is at a slower speed than best L/D.

If you fly at min. sink speed, your glider will stay airborne for the longest time. If you're trying to get back to the strip in a tailwind, flying at min. sink may get you there because you will be airborne longer than if you were flying at best L/D where the sink rate is higher.

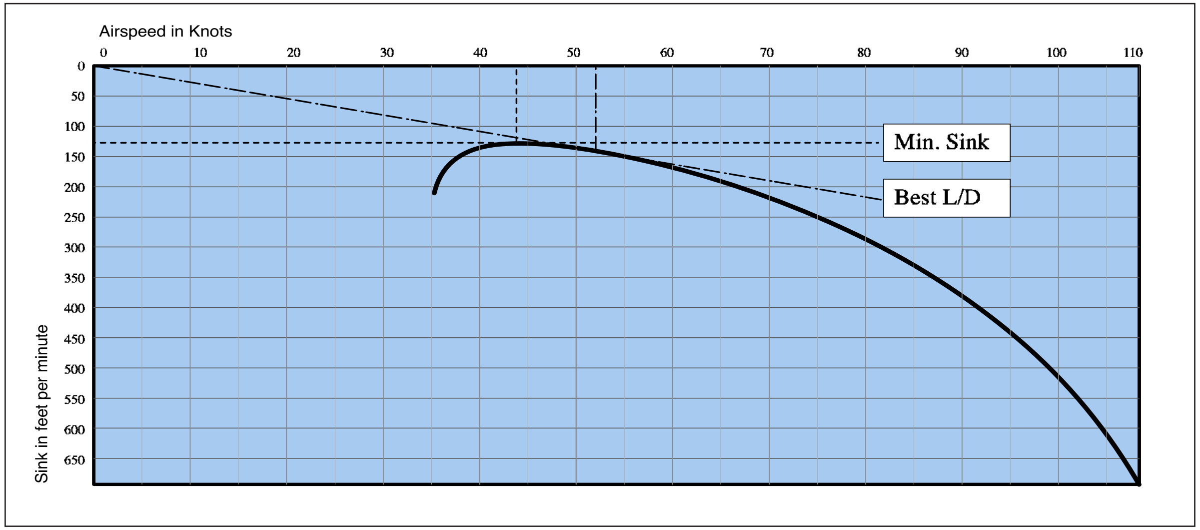
If a glider has a best L/D of 40 at 52 knots, the sink rate is equal to 52/40 = 1.125 knots or 130 feet per minute.

Glider Polars

The sink rate of a glider can be measured at various airspeeds and graphed. This is called a polar and is usually available in the flight manual for each glider.

Min. sink can be found by drawing a line from the top of the curve to the Y or vertical axis and reading off the sink rate.

Best L/D can be found by drawing a line from the intersection of the X and Y axes so that it meets the curve tangentially. We'll look more at glider polars later.



Gravity, lift and drag.

The main forces on a glider are gravity, lift and drag. There's not enough room here to discuss where gravity comes from in any detail and since it is unlikely to change any time soon, we'll concentrate on where lift and drag come from.

How a Wing Generates Lift

To some extent, it is not essential to know how lift is developed to fly a glider. However it is essential to understand how a wing stalls and to understand stalls we need to have an understanding of how lift is developed.

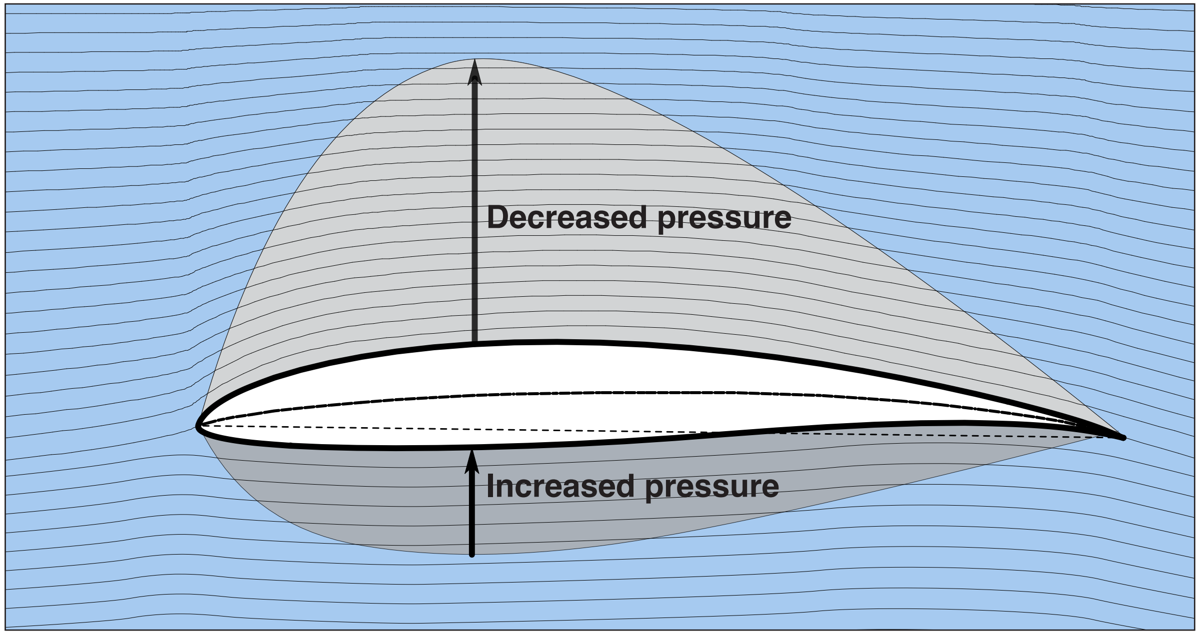
Lift is generated by the airflow around the glider's wings. You can generate lift from almost any shape of wing, even a flat plate, but it will be very draggy and inefficient. Aeroplane wings generate lift well because their shape is optimised to produce good lift and low drag.

The sectional shape of an aeroplane wing is called an aerofoil and on gliders the aerofoil shape used on wings is designed to produce the necessary lift over the normal range of flying speeds with minimum drag.

Lift is generated when an aerofoil moves through the air, accelerating and deflecting the airstream downwards. The wing exerts a force on the air and this is met by an equal and opposite reaction upwards and backwards from lift and lift-induced drag.

The lift generated is proportional to air density and the airspeed squared. When a wing flies faster, it generates more lift. At high altitude where the air is thin, a wing generates less lift than at ground level for the same airspeed.

As a wing moves through the air, it affects the air well in front of the wing as well as behind as shown by the streamlines around the foil. There is considerable upwash well in front of the wing and downwash a long way behind.



Angle of attack

The angle of attack of an aerofoil is the angle at which it meets the airflow. At some angle of attack, the aerofoil will generate no lift. As the angle of attack increases, the amount of lift will increase up to a point where the air cannot continue to flow smoothly around the aerofoil and the aerofoil is said to have stalled.

Normally an aircraft wing is fitted to the fuselage at some shallow angle. This is called the rigging angle or angle of incidence.

The tailplane or horizontal stabiliser of an aircraft is set at an angle of incidence less than that of the main wing's rigging angle because the tailplane does not normally provide lift and is only required to control the angle of attack of the main wing and to maintain stability in pitch.

In any case, it's essential that the tailplane is designed to stall later than the main wing so that control is possible close to the stall.

The movement of the wing section through the air generates two other forces; drag and a pitching moment.

Profile Drag

The drag on a glider can be separated into two causes. Profile drag is the drag caused by the shape of the glider. A glider shaped like a brick would have more profile drag than a glider shaped like a teardrop.

You can reduce the profile drag on a glider by polishing the wings, sealing leaks and taping up gaps but overall, profile drag is dependent on the shape of the aircraft.

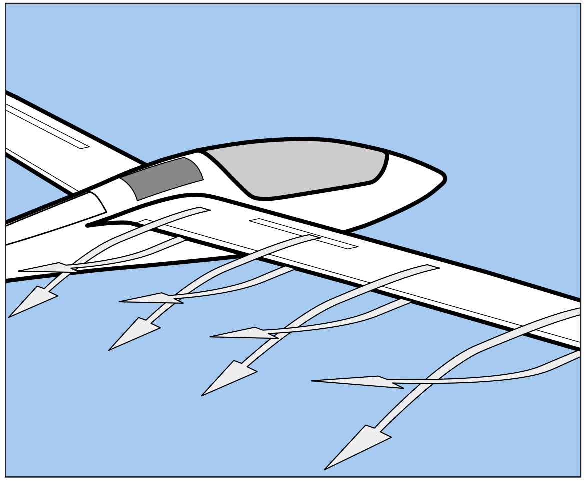
Profile drag will be higher on a rough or dirty wing compared with a smooth one and will increase if the wing is covered with rain or bugs.

Induced Drag

The other drag force which acts on a wing is induced drag or vortex drag. It's related to the spiral rotating vortices which trail behind a wing or any lifting surface.

Induced drag is caused as a direct result of generating lift. And the more lift which is generated by a wing, the more the induced drag will be generated too.

At low speeds, when thermalling for example, most of the drag on a glider is induced drag.



The angle of attack of the wing and therefore the lift coefficient is high and the airspeed over the wing is low.

When a glider is flying fast, the angle of attack and the lift coefficient can be lower while generating the same amount of lift. Therefore the wing produces less induced drag. At higher speeds, a much greater proportion of the total drag on the glider is profile drag.

The amounts of profile and induced drag can be graphed against airspeed. The result shows a marked U shape with the lowest total drag corresponding to best L/D.

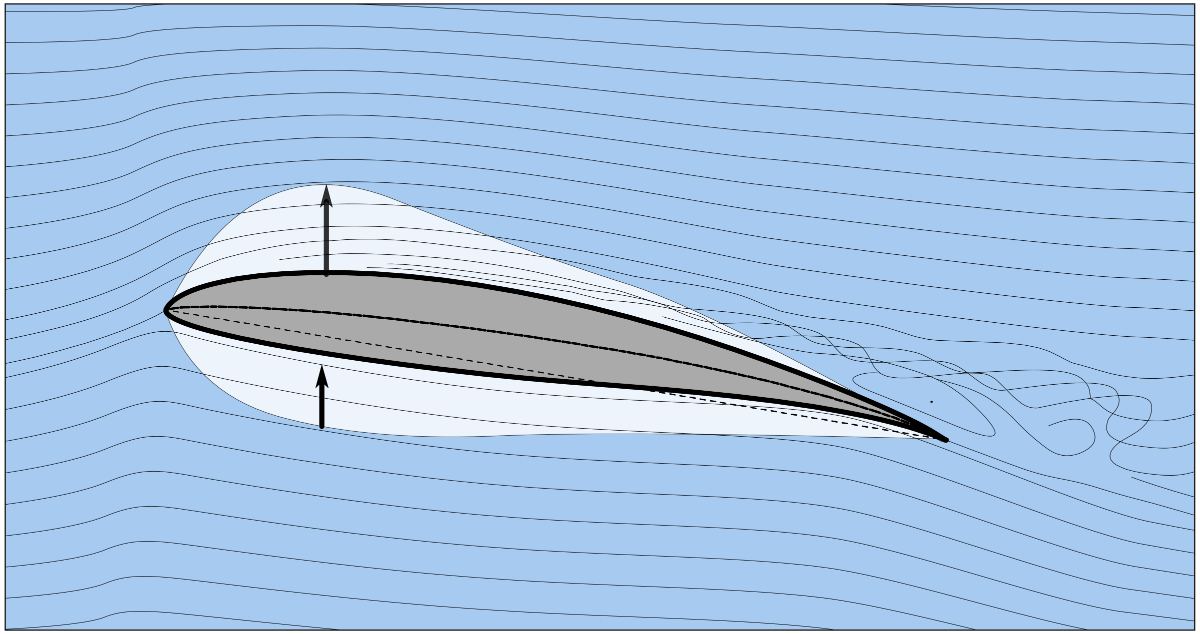
Stalling.

An aerofoil is said to stall when its critical angle of attack is reached. At this point, there is a fairly rapid reduction in the lift coefficient. Lift is still being generated but the amount of drag increases because the air can no longer flow smoothly around the foil.

The amount of lift generated by a particular aerofoil profile depends largely on two factors; the speed of the air flowing around the foil, and the angle of attack of the aerofoil.

At a low angle of attack, little or no lift will be produced. As the angle of attack increases and the foil meets the airflow at a steeper angle, the amount of lift generated increases. At some critical angle of attack, the airflow is unable to stay attached to the upper surface of the aerofoil and it separates in a turbulent bubble.

There's a large increase in drag and a decrease in lift and because of the flow separation, the section is said to have stalled. It's important to note that the point of stall is related to the angle of attack, not the air speed even though we may talk about the stall speed of a glider.



Also, note that at the stall, the wing is still generating *some* lift… but as the angle of attack increases beyond this point, the lift decreases and drag increases by a larger amount.

If a stall occurs at the wingtip of a glider, the wingtip will lose lift and this will roll the glider and if left to its own devices, the glider may go into a spin. For that reason, a glider's wing normally uses several aerofoils from the wing root to the wingtip, chosen to make sure that the critical angle of the aerofoil is greater at the wing tip than the wing root.

This is to make sure that the wingtip stalls later than the wing root to avoid wing drops and to make sure that the glider remains controllable at the stall. In some wing designs, the wingtips have a lower angle of attack to the wing root to achieve the same effect… the wingtips stalling later than the wing root.

We'll look at the effects of stalling on the whole glider later.

Glider Aerofoils

In normal straight flight at a steady speed, the amount of lift required is equal to the weight of the glider. As the glider's speed changes, the angle of attack also changes..

Over the years, since people have been designing and flying gliders, a huge amount of work has been done on aerofoil sections. Initially, glider pilots just wanted to ridge soar but when pilots started to go cross country, it was realised that a glider had fly fast to do long distance flights and aerofoils had to be optimised not only for thermalling flight but also for higher speeds between thermals.

This has lead to aerofoil sections which are designed with what is termed a "low drag bucket" after the shape of the drag curve on a graph. What this means is that there's a range of slow speeds as well as a range of higher speeds at which the aerofoil section will perform at its best.

The Wright brothers had a primitive (and fairly misleading) wind tunnel which they used to develop the aerofoil sections used on their gliders and propellers. Nowadays, most aerofoil development is done using computers, however this has not always resulted in the best profiles.

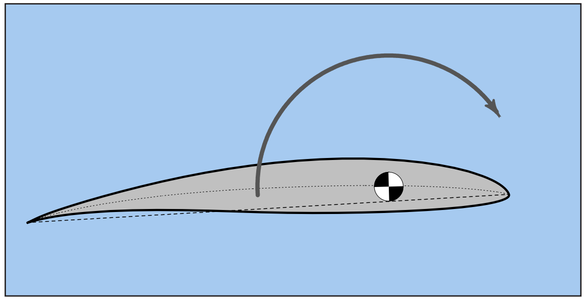
Some aerofoils are badly affected by the build-up of bugs or rain. It's possible for the performance of a glider to be degraded a lot by a rain on the wing… the L/D goes down and the stall speed goes up… and this affect is most noticeable when you're approaching to land.

With some aerofoils, there can be a range where the angle of attack will increase as the stick is pulled back and though the drag will increase, the lift won't. Typically, this is felt on wings with flaps when rounding out on landing. The stick is pulled back to keep the glider from sinking too fast towards the ground but the increase in drag means it actually sinks faster.

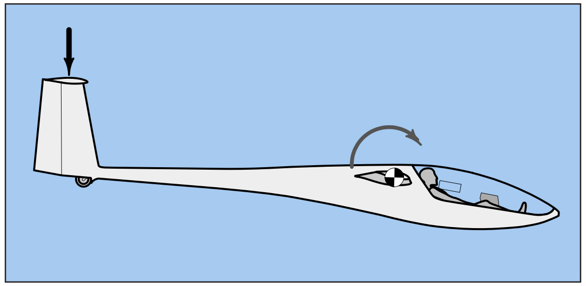
It is important to look for this information in the flight manual or handling notes of a glider and talk to instructors and fellow pilots when moving to a new type of glider.

Pitching Moment

Almost all aerofoils generate a pitching moment, or a force which tends to rotate the wing and cause the glider to pitch nose-down. The amount of this pitching moment depends on the angle of attack, and therefore the speed at which the glider flies.

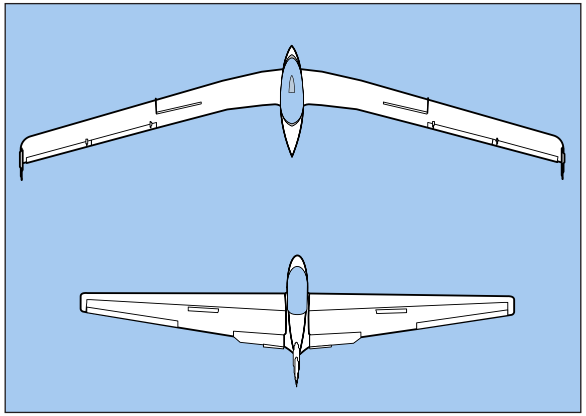


To counteract this force, gliders normally have a horizontal stabiliser or tailplane. This is aligned to the airflow so that at normal flying speeds the tailplane generates a downwards force equal to the pitching moment.



Since the pitching moment varies depending on the angle of attack of the aerofoil, to maintain a steady airspeed, the corresponding force on the tailplane must change. This is done by adjusting the elevator position and normally set with the glider's trim control. You can read more about this in the controls section of this book.

So what about flying wings which don't have a tailplane or elevator and how does a wing work in inverted flight? The answer to these two is quite simple.

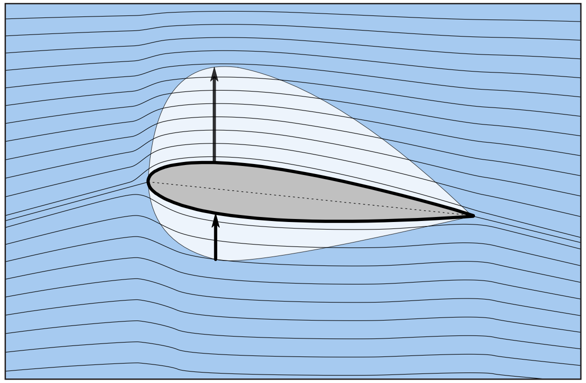


Flying wings are normally made in two types. The swept back delta planform typified by the modern hang glider or SB 13 experimental sailplane, or the straight 'plank' planform which is not so common. Plank style flying wings, such as the Marske Pioneer, use a special aerofoil section where the camber line is reflexed. That is, the trailing edge of the foil is kicked up a little to neutralise the pitching moment at all angles of attack.

In the case of the swept wing glider, the wingtips are angled back, behind the wing root and twisted so they operate at an angle of attack which gives the same down force as a conventional tailplane. On a swept flying wing the angle of attack of the wingtips is fixed and on a plank the reflex is fixed. So these geometries are only efficient at one speed. The overall performance of a flying wing can't equal that of a conventional glider.

As mentioned before, you can generate lift from almost any surface. When a glider is flying upside down, the wings still generate lift even though the airflow is on the "wrong" side of the foil section. The wing is not very efficient when flying inverted, so a glider is unlikely to break any cross-country records flying like this.

Aircraft that are designed for aerobatics normally have a symmetrical aerofoil section on their wings. That is, there is no camber, only varying thickness. To generate lift, the wing has to be angled at the right angle of attack to the airflow and it doesn't matter if the wing is one way up or another.

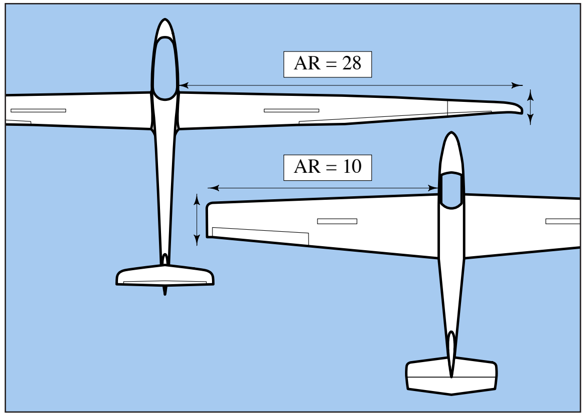


Sailplanes don't use a symmetrical foil on their wings because compared with a normal sailplane section, symmetrical sections generate much more drag for a given amount of lift. Glider tailplanes often use a symmetrical section because the tailplane functions as a stabiliser and may be required to generate a positive or negative pitching force.

On modern aerobatic aircraft like the Edge and Extra, the fuselage is foil shaped so it too can generate lift when flying knife edged… and probably make a heap of drag too.

Aspect Ratio

Almost all sailplanes have long, skinny wings. Almost all crop dusting aircraft have short stubby wings. The reasons for these differing wing planforms are to do with efficiency and the purpose of the aircraft. For a glider and a crop duster of the same weight, the wings have to generate the same lift.

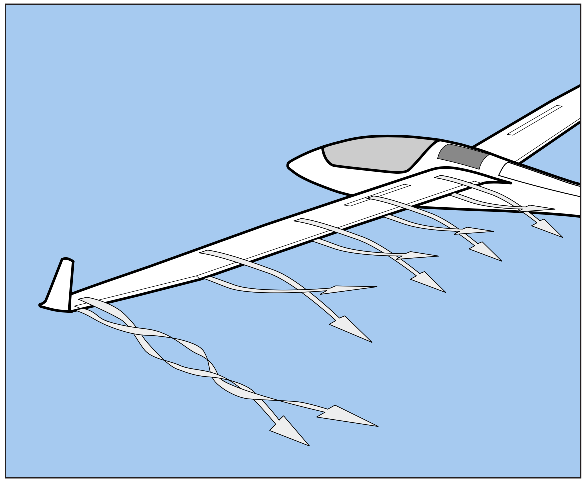


It is far more efficient to move a large amount of air by a small distance as with a glider wing, than to move a smaller amount of air by a large distance as the crop duster wing does. The lift produced is the same, but the drag of the glider wing is far less.

The fineness of a wing is called the Aspect Ratio or AR, which is the span of the wing divided by the mean chord, (the average distance from the leading to the trailing edge). High aspect ratio wings are more efficient than low aspect ratio wings and most modern gliders have an AR between 20:1 and 30:1.

Tip Vortices

Part of the reason that aspect ratio is important is that nasty draggy things are happening to the air at the wing tips. The air flowing over the upper and lower surfaces of the wings comes together at the trailing edge and rolls up to form what's called a trailing edge vortex. This is at its worst at the wingtips. High aspect ratio wings have proportionally smaller tip vortices than low aspect ratio wings.



Winglets

It's been discovered that adding little vertical wings or winglets can reduce the tip vortex and improve the efficiency of a wing by a small amount (Probably less than 2%.) In fact this gain is true only at one air speed, but it is also claimed that winglets improve handling near the stall and when steeply banked. Most people like the look of gliders with winglets so fashion or not, they are probably here to stay!

Roll Rate

Back to the crop duster's stubby wings for a minute. They are there for a reason. In fact there are several reasons, but one important one is manoeuvrability. Crop dusters have to fly out of very small paddocks and turn rapidly at the end of a run before beginning the next one.

With a low aspect ratio stubby wing, it is easy to get good manoeuvrability. In this case it's called roll rate… the time it takes to roll the wings from 45° on one side to 45° on the other.

Aerobatic aircraft need a high roll rate and so they have stubby wings. The downside of a high aspect ratio wing is a relatively poor roll rate because the wings have to move such a lot of air as they roll.

Most gliders have a roll rate of about 4-5 seconds which is sedate compared with perhaps 1 second for an aerobatic aeroplane. In comparison, roll rates of open class gliders with wingspans around 30 metres are glacially slow.

Wing Loading

The wing loading for a glider is the weight of the glider divided by the wing area and it is measured in kilograms per square metre. Typical wing loadings in modern gliders are between 35 and 50 kgs/M^2. Gliders with a low wing loading can be expected to perform well in light conditions while gliders with a high wing loading are optimised for flying fast in stronger conditions.

Over the years, there has been a trend towards higher and higher wing loadings because a high wing loading equates to a better L/D at faster speeds and therefore a greater capability to fly cross country. The downside of this is that modern gliders are heavier, land faster and are not as suited to flying on weak days.

Most high performance gliders can carry ballast in the wings. Normally this is in the form of water, held either in the wing itself or in flexible water bags inside the wing. The ballast is dumped either before landing or when conditions get light. It is essential to dump water ballast when wave soaring where temperatures are very low and water ballast may freeze and damage the wings.

The amount of lift generated by the wings depends on the speed of the air over the wing and the angle of attack of the wing.

The amount of lift required to be generated at any time depends on the wing loading.

The wing loading depends on the wing area (which is fixed) and the weight of the aircraft which changes.

The mass of the aircraft is the mass of the airframe plus the mass of the pilot(s), clothes, parachutes, balance weights, baggage, fuel, plus any water ballast.

The weight depends on the mass of the aircraft multiplied by the acceleration due to gravity or G. Apparent weight can change rapidly in moderate to high G manoeuvres such as winch launching, steep banking and aerobatics.

Glider Stability and Control

The need For stability

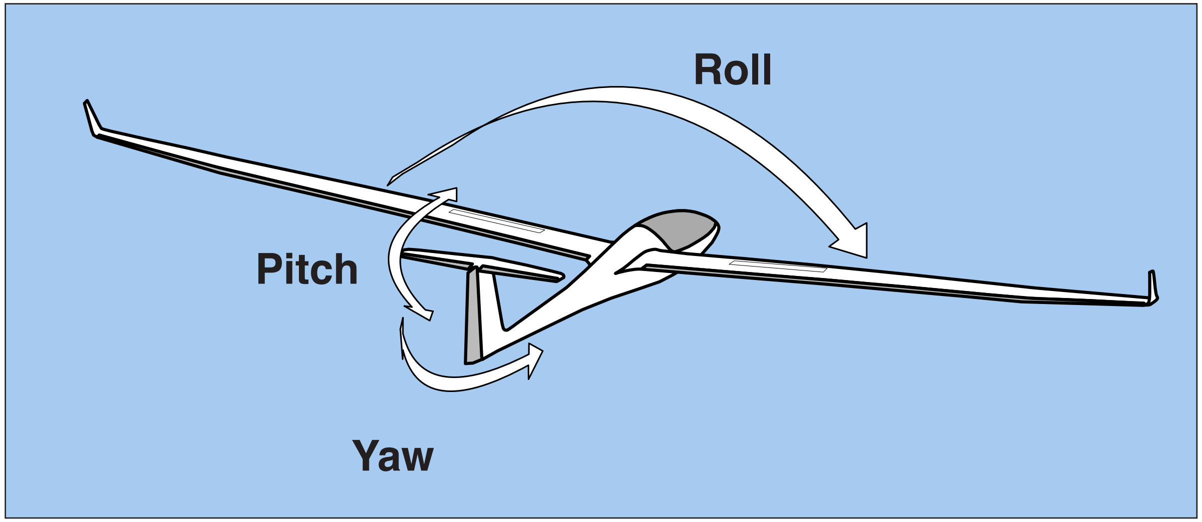
Modern gliders are designed to be both stable and controllable. If a glider is in straight and level flight and the pilot takes his hands and feet off the controls, the glider will fly on by itself, and if disturbed, the glider will tend to recover automatically. If the glider is disturbed by a gust or turbulence, it also tends to return to a stable trim or speed without any input from the pilot.

Having a totally stable glider sounds like a great idea but over time, pilots and designers have discovered that too much stability is not a good thing.

Back in the early years of flying, John Dunne designed a swept flying wing biplane that was flown down the length of England with no control input.

This was thought to be a great idea and resulted in aircraft like the British B.E.2c fighter which was so stable that pilots found it almost impossible to escape from an attacking aircraft. These very stable aircraft were also hard work to fly and very tiring.

The other side of the coin is aircraft like Charles Lindbergh's Spirit of St. Louis in which he flew single handed between New York and Paris in 1927. This aircraft was quite unstable and required a constant hand on the controls, something which Lindbergh said helped because it stopped him going to sleep!



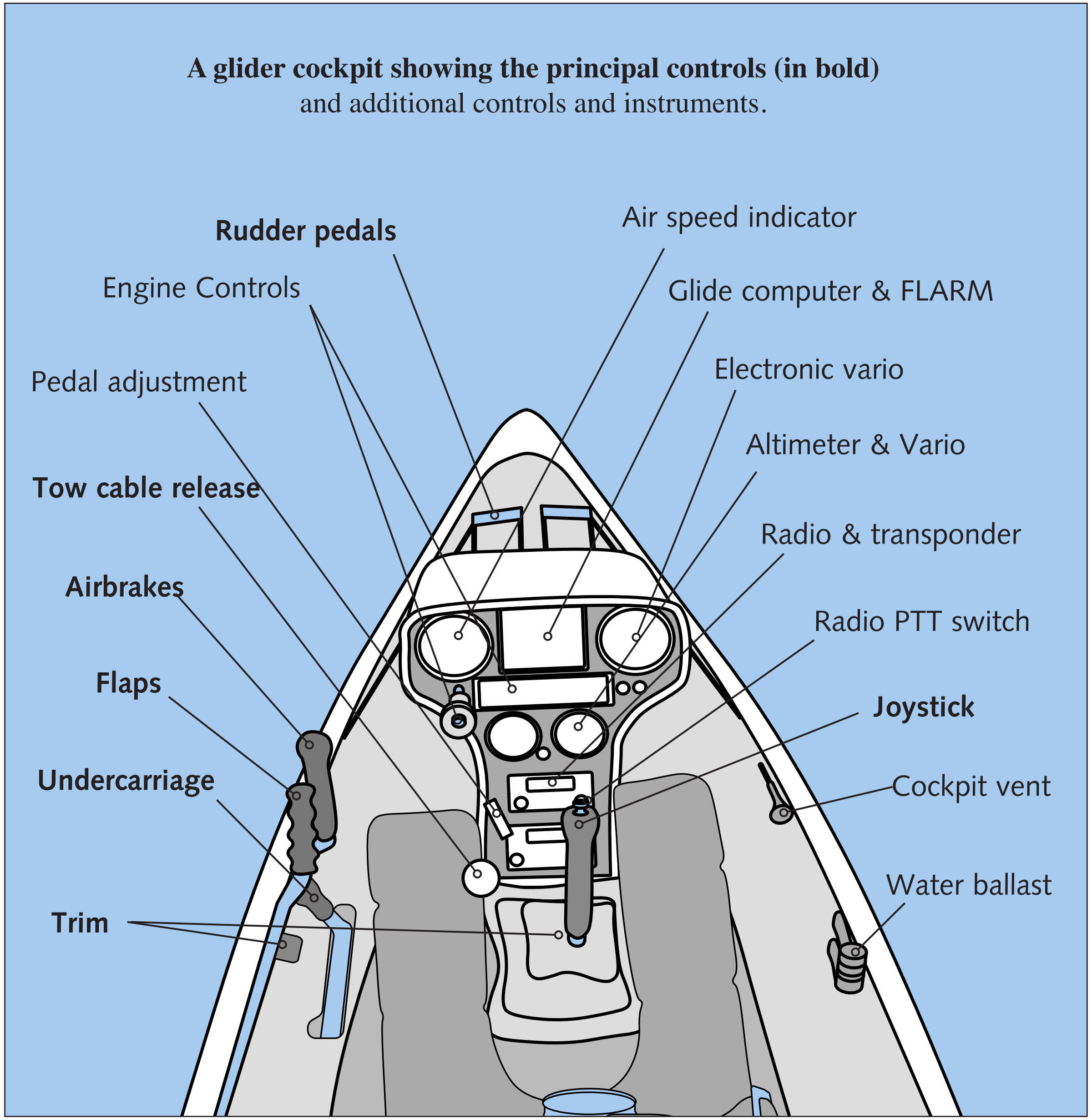
For that reason, gliders are designed to have enough stability to be relaxing to fly but not too much. Training gliders are more stable than more advanced gliders.

Stability and the increase of pressure needed to move controls are a requirement of the standard (JAR 22 and EASA CS 22) to which all modern gliders are designed.

Primary Controls. Joystick and Rudder.

A glider in flight is free to move in three planes. Pitch, roll and yaw.

This movement is controlled by the main controls; joystick and rudder pedals. Fore and aft movements of the stick move the elevator to control pitch. Side to side movements of the stick move the ailerons to control roll. The rudder pedals are connected to the rudder to control yaw. In fact, the effect of all these controls is linked… we'll get to that later.



Secondary controls.

The glider has a number of secondary controls. A trim control is used to reduce the stick force when controlling the elevator. There's a tow cable release which is pulled to release the glider from winch or aerotow cables.

There's an airbrake handle which is used to lock, unlock and control the airbrakes. There are usually controls for features like cockpit ventilation, foot pedal adjustment and frequently seat and headrest position. This basic set of controls is fitted to every training glider.

Most gliders that you'll fly post-solo have more controls than basic training gliders. Gliders with retractable undercarriages will have an undercarriage lever. Gliders fitted with flaps have a flap lever. And if a glider can take water ballast, there will be a dump valve control.

The joystick is in almost all cases, fitted centrally and operated with the right hand and the rudder is operated by foot pedals.

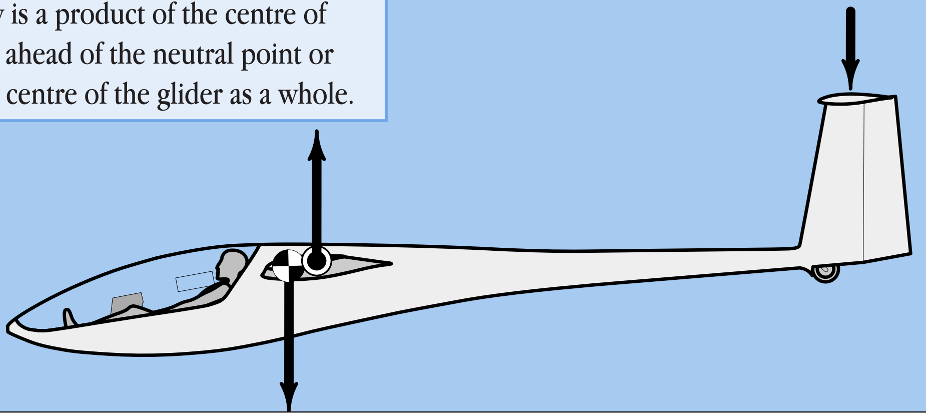
Apart from colour coding some controls, that's about the limit to standardisation in cockpit design. It may seem logical that if the joystick is operated with the right hand, then everything else should be operated with your left hand but this is not always the case.

Undercarriage controls may be on the right or left side of the glider, so you may have to move your hand off the joystick to raise or lower the undercarriage and the control may work in either direction… in one typeof glider, pulling the lever back will raise the undercarriage and in a different type, it will lower the undercarriage.

Trim controls may be at the base of the stick operated with the right hand, on the left side cockpit wall and operated with the left hand or in both positions.

The essential cockpit controls are colour coded; airbrakes have a blue handle, the trim control is green, the canopy emergency release is red and the cable release is yellow but that's all you can rely on. So it is essential to study a glider's flight manual before you fly a new type.

It's important to check the cockpit markings when raising or lowering the undercarriage in flight to make sure the undercarriage will be where you want it to be. It also goes without saying that lowering the undercarriage before landing should be done at a height which allows this check.



Pitch stability is a product of the centre of gravity being ahead of the neutral point or aerodynamic centre of the glider as a whole.

The joystick - elevator

The joystick is connected by a precision set of linkages to both the elevator and the ailerons. Fore and aft movements of the stick move the elevator and side to side movements of the stick move the ailerons.

The elevator controls the pitch of the glider and the pitch controls the speed of the glider. In fact the elevator is the only speed control on a glider. Pushing the stick towards the nose, away from the pilot, pushes the nose of the glider downwards and it will begin to accelerate.

However, as the glider accelerates, the designed-in pitch stability of the glider will try to lift the nose again, slow it down and the stick will want to return to its original position… as the speed increases, the pilot will feel an increase in force on the stick trying to move backwards, towards the pilot.

Pitch stability is a product of the position of the glider's centre of gravity and the position of the neutral point. The neutral point is the point through which all the aerodynamic forces on the glider act… the lift and drag of the wings, tailplane and fuselage etc.

When the centre of gravity is ahead of the neutral point, a nose up disturbance will produce an increase in lift behind the centre of gravity which tends to pitch the nose back down and restore trimmed flight. A nose down disturbance produces a reduction in lift aft of the CofG generating a nose-up moment.

To maintain this pitch stability, the CofG position must remain within its design limits. As the CofG moves aft, the glider becomes increasingly unstable in pitch and at some point becomes uncontrollable.

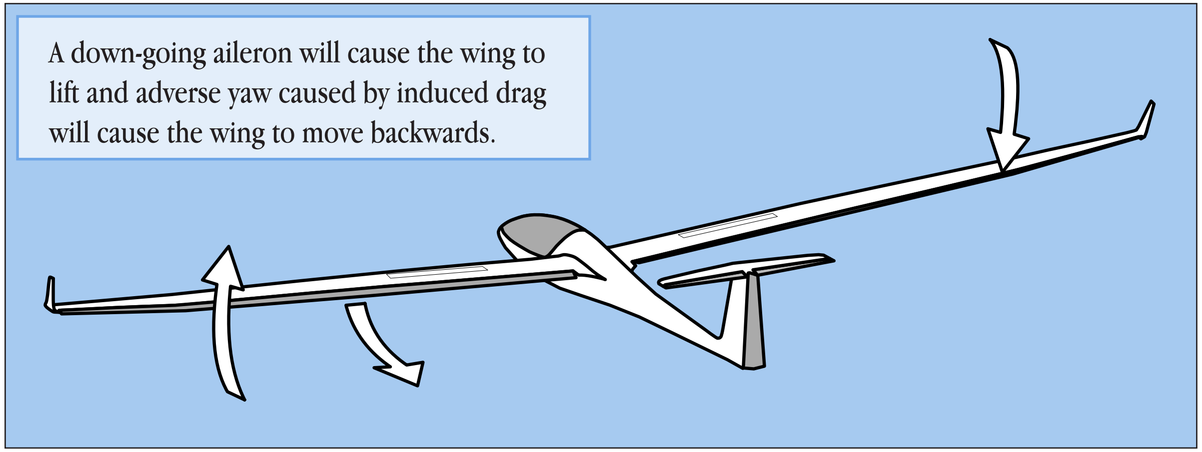
As the CofG moves forwards, it becomes increasingly nose heavy to the point where there is not enough elevator movement to control the glider. This is why it is so important to take cockpit loading seriously.

While gliders are stable in pitch, they are fairly neutrally stable in roll and yaw and left unattended in a bank, a glider may tend towards spiral instability.

The joystick - ailerons

Side to side movements of the stick move the ailerons. A movement of the stick to the right, causes the right aileron to deflect upwards and the left to deflect downwards.

The upward deflection of the right aileron reduces the lift being generated by the right wing and the down-going aileron on the left side increases the lift on that side. This causes the glider to roll. However another effect gets in the way.



Remember the previous section on lift and drag? Generate lift and you get induced drag. Generate more lift and you get more drag. When the left side aileron's downwards movement causes the wing to generate more lift, it also causes more drag. The result of this is that the left wing goes up… and it also yaws backwards due to drag. This is called adverse yaw.

Adverse yaw

Adverse yaw is very noticeable on sailplanes because of their wingspan. With the extreme wingspans of open class gliders, drag induced yaw can be so much that additional control surfaces such as wingtip spoilers may be required to roll the glider.

Adverse yaw is most noticeable when thermalling because the glider is flying slowly and the wings are operating at a high angle of attack and producing a lot of drag.

To counteract adverse yaw, two things are done. The first is purely mechanical. The aileron linkages are designed so that the downwards deflection is less than the upwards deflection. This arrangement is called differential ailerons and reduces adverse yaw. Almost all gliders are designed with differential ailerons.

The other thing done to counter adverse yaw is done by you, the pilot by putting in some rudder in the direction of the turn to counter adverse yaw when banking. In powered aircraft, pilots rarely use the rudder pedals. Glider pilots use them all the time.

Roll stability

Gliders have some stability in roll which is caused by two factors. The first is lateral or roll damping. As the glider banks or rolls, one wing accelerates downwards as the other accelerates upwards. The downwards movement causes more air to flow over that wing and increases the angle of attack of the airflow and therefore increases the lift on that wing.

At the same time, the angle of attack of the opposite wing is decreased, reducing the lift. These effects act to oppose the roll… which is why it is called lateral or roll damping. Roll damping happens when a glider is rolled by the pilot moving the stick and it also occurs if the glider is rolled by a gust or updraft.

The greater the wingspan, the more the damping. Lateral or roll damping does not try and level the wings again. Once a glider is rolled and stable in a turn, roll damping will tend to oppose a change on the bank angle.

Roll damping is always present except if a wing is stalled. In the case of a stalled wing, the glider will roll towards the stalled wing and because of the loss of roll damping, will continue to roll into a spin unless the pilot takes corrective action, the airflow is reattached and the stall condition removed. Sharply tapered wings have less roll damping than parallel chord wings, and narrow wingtips are more prone to tip stalling than longer chord wingtips both of which can lead to an aircraft which is easy to spin.

The wing of a modern glider is designed so that as much as possible, a stall will start at the wing root near the fuselage while the tip keeps flying allowing control close to the stall. As a stall moves outboard, aileron control will become more and more sluggish and ineffective.

Gliders also achieve roll stability with dihedral. Dihedral is the upward angle of the wings from the horizontal. Modern gliders have wings that are immensely strong, but quite flexible and which bend up at the tips in level flight, sometimes in a pronounced arc, increasing any dihedral that might be measured on the ground.

Without dihedral, a wing is neutrally stable in roll. That is, there's no force on a banked wing trying to roll the wings level. Any roll which starts will be damped by roll damping, but once the rolling motion has ceased, there will be no tendency to correct the roll.

The way dihedral works is somewhat complex. When banked, the aircraft will tend to sideslip towards the lower wing. The sideslip changes the angles of attack of the two wings differentially and it is this which provides the powerful corrective rolling action of dihedral.

Rudder pedals

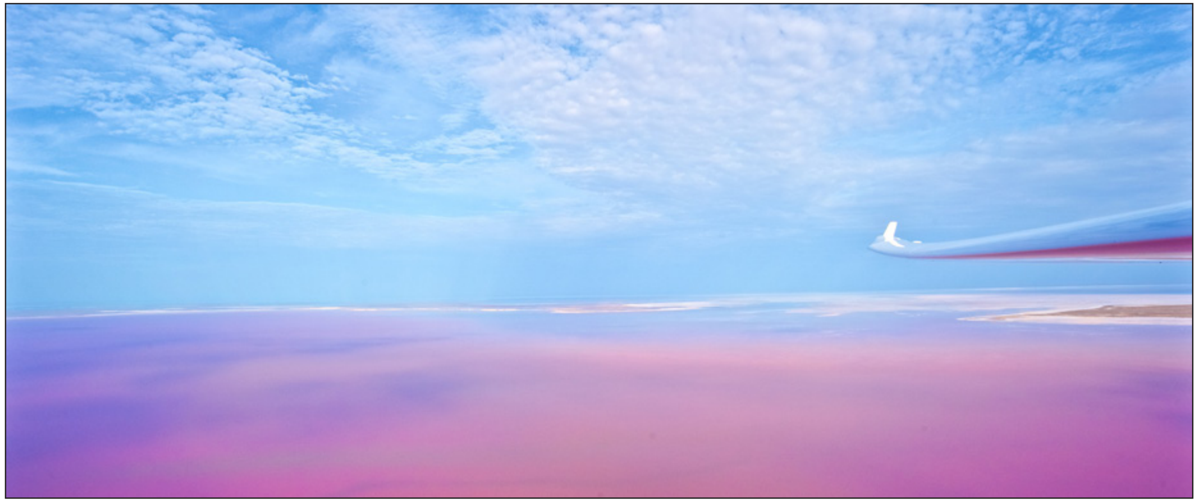
The rudder pedals move the rudder, normally by a simple cable connection between the two. Push with your left foot, and the rudder moves left which yaws the glider to the left. In the air, the rudder is almost always used in combination and coordination with the ailerons when banking in a turn to correct adverse yaw.

Yaw or directional stability

If a glider is disturbed laterally by a gust, the glider will tend to yaw to one side, but only by a certain amount. As the glider yaws, the airflow meets the fin and rudder at an increasingly large angle of attack. This creates a lift force which tends to yaw the glider back into line with the airstream, much as the feathers on an arrow keep it pointing straight. This creates yaw stability.

Coordinating turns

A glider turns by banking, much in the same way that a bicycle has to lean over when cornering. When a bicycle leans in a turn, the force you feel is in line with your back and the angle of lean of the bike. When the bike leans more, it turns tighter and vice versa.



The earliest aviators tried to fly their primitive aircraft flat in turns but perhaps because of their bicycle experience, the Wright Brothers and Glenn Curtis, both bicycle builders, realised from the beginning that it was essential to bank an aircraft in a turn to stop it skidding or sideslipping.

The air is much less grippy than a road surface so a glider can easily slip sideways or skid if it is not banked properly with the correctly coordinated amount of aileron and rudder.

If a glider is flown well in a turn, it is said to have made a coordinated turn. If not, the turn may be a skidding turn where the glider moves outside the arc of the turn, or a slipping turn where the glider slips sideways, inside the arc of the turn.

So how do you tell if a turn is properly coordinated? Fortunately the basic instrument is both simple, accurate and cheap. It's the yaw string, that length of wool stuck to the front of the canopy and it was probably invented by Orville Wright himself.

The yaw string

In a properly coordinated turn, the yaw string points more or less straight back, in line with the glider. If the glider is slipping or skidding, the airflow over the canopy will not be straight and the yaw string will move sideways. Applying more or less rudder will straighten up the string. In straight and level flight, the yaw string should be pointing up and back… anything else and there will be excess drag.

It's claimed that having the yaw string pointing slightly towards the higher wing (or pointing outside the turn 5-10º) may give better climb rates than having the string perfectly central. It appears to be easier to circle in some gliders this way. What's always wrong is to have the yaw string pointing inwards in a turn, towards the lower wing.

Pitch, Attitude and Speed

The elevator is the only speed control on a glider. As a glider's speed changes, you may notice a change in noise level in a training two seater but in a high performance glider the change in wind noise may be slight.

So without spending all your time looking at the airspeed indicator inside the cockpit, how do you tell how fast the glider is flying? The answer is this; the position of the nose of the glider in relationship to the horizon tells you the speed of the glider.

As the glider pitches nose up or nose down under the control of the elevator, the distance between the horizon and the nose changes very visibly.

The position of the nose of the glider relative to the horizon, or more correctly, the angle of the glider's fuselage to the horizon is known as "Attitude".

When an instructor says "your attitude is wrong!" in most cases they're referring to the position of the nose of the glider with respect to the horizon and not your personality.

Attitude equalling speed holds true whether the glider is in straight flight or if it is circling in a thermal. The relationship of the nose to the horizon controls the speed of the glider.

You will probably see to start off with, that when you are flying in turns, the nose of the glider bobs up and down and when your instructor is flying, the nose of the glider appears nailed to the horizon. Don't stress too much! It's a skill that comes with practice.

There is something very important to remember about attitude. Attitude equals speed… *so long as the glider is given time to accelerate to the stable speed for that attitude*!

If you push the stick sharply away from you towards the nose of the glider, the nose will drop but the airspeed will take some time to increase to a stable value.

If you try and roll the glider at times like this, before the airspeed has built up, you risk stalling a wing and spinning the glider. We'll look more at this later.

Safe Speed Near the Ground

Whenever you are flying near the ground, at any stage of flight other than after rounding out, you must maintain a safe airspeed. This speed will vary slightly from glider to glider because it is based on the glider's stall speed but it's always known as "Safe Speed Near the Ground.

Safe speed near the ground is *never less than 1.5 times the stall speed (Vs) of the glider.* For example, if the stall speed of the glider is 38 knots, the safe speed near the ground is not less than 57 knots.

Stall speeds are not normally on cockpit placards but they are in the glider's flight manual. The stall speed will vary, depending on factors like the amount of airbrakes and flaps being used. Using full airbrakes may add 4-5 knots to the 'clean' stall speed and using negative flap settings may add the same amount. These stall speeds are also affected by the weight of the glider. The stall speed of a fully water ballasted single seater may be fully 10 knots faster than when empty. The same effect applies to a two seater flown with one or with two pilots.

1.5 times Vs by itself is not always safe enough where gliders are close to the ground, for example during landing or takeoff, or when ridge soaring. If the glider is hit by a strong wind gust, it will lose airspeed. If the gust dies rapidly, the glider may then be flying too slowly. This is dangerous when flying close to ground.

So we add half the wind speed to calculate the approach speed. This means when landing the glider mentioned above into a 20 knot wind, our safe speed is 38 + 19 + 10 knots.

It's really important to read flight manuals and commit essential stall speed range to memory and use conservative values when calculating safe speed near the ground.

Where is close to the ground? Obviously it includes the take-off, circuit and landing phases of flight, but it also includes ridge soaring, thermalling at low altitude and crossing ranges and hills. These are all places where wind gusts, rowdy thermals and turbulence can upset the glider.

A spin close to the ground may be fatal. A modern, slippery glider, fully water ballasted, may take more than 750' to recover. You may not be high enough to survive this altitude loss during spin recovery. Modern gliders lose more height in a spin than older, draggier gliders so you need to maintain control authority at all times near the ground. You won't have enough near the glider's stall speed where the controls, especially the ailerons, get soft and waffly.

Flight manual may suggest and approach speed significantly lower than the 1.5 times Vs recommended in Australia. This is quite wrong for our conditions.

In northern Europe conditions are mild and it might be OK to use a slightly slower approach speed but it is certainly not good practice in Australia. In fact, in southern Europe, where conditions are closer to those in Australia, they fly using the same safe speed near the ground as we do.

Whenever you are flying close to the ground, especially when ridge soaring or thermalling low and may be off your guard, regularly glance at the ASI to check the speed. If your safe speed near the ground is something like 57, round it up to 60 instead of rounding it downwards, to make it easier to check against the markings on the ASI dial.

Turning the glider

Unlike the majority of aircraft (other than crop sprayers), gliders spend a lot of time turning. On a typical cross-country flight, over 30% is spent turning. Many powered aircraft may only make half a dozen shallow turns in a flight. Learning to turn properly is an essential part of your training.

Whenever you make a change of direction in a glider, you must look out to make sure that the air is clear in the direction of the manoeuvre. Before rolling into a turn, look right around in the direction of the turn to make sure there are no aircraft close by. Never do a sharp pull-up into a turn because you cannot see if anyone is above and behind your glider.

When entering a thermal with other gliders, be very watchful because apart from the gliders already in the thermal, others may be joining the thermal from all directions and altitudes.

Gliders are turned by rolling the glider into a bank and using an appropriate amount of rudder to correct adverse yaw. The rudder itself plays little part in getting a glider to turn.

The Wright brothers were some of the earliest people to understand that in order to turn, an aircraft has to bank, just like the bicycles the Wrights made. Many early pilots believed that you could make flat turns with the rudder alone but the obviously better performance of the 'banker's' proved them wrong.

Coordinated movements of the ailerons and rudder are always used to turn a glider. If not enough rudder is used, the glider slips sideways into the turn… side slipping, and if too much rudder is used, the glider moves out in what's called a skidding turn. Sideslipping is the opposite of skidding.

When turning, the nose of the glider should track smoothly along the horizon and not bob up and down or and the rotation speed should remain more or less constant. Coordinating aileron and rudder inputs to get this right. As you roll into the turn, a bit of back stick will be required to keep the nose of the glider on the horizon.

Alternate your lookout between the nose of the glider to check attitude and over your shoulder in the direction of the turn to make sure the airspace is clear.

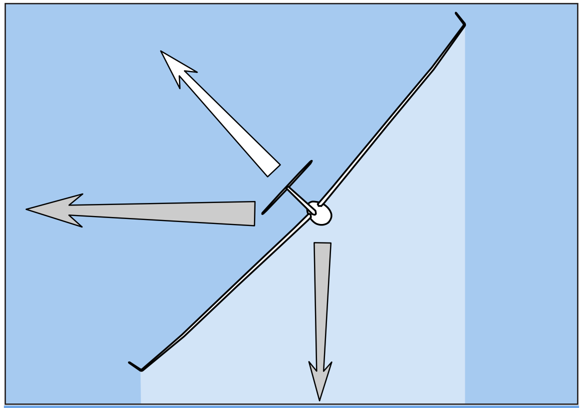
The glider is rolled into a bank with the joystick. As the joystick is moved sideways, drag on the rising wing increases and the glider tends to yaw out of the turn. Rudder is applied simultaneously with the stick movement to prevent this adverse yaw.

Once banked, little aileron is needed to maintain the bank angle and pressure on the rudder pedals can be relaxed.

To return to straight flight from a turn, opposite ailerons are applied to roll the glider out of the turn as well as a proportional amount of rudder to counter the adverse yaw from the down-going aileron.

When turning, corrections with one control will almost always require some adjustment to another. When a glider is turning with correct amount of aileron and rudder, it is said to be in a coordinated turn. The amount of rudder to put in depends on a number of factors. Some gliders require less foot than others when coordinating turns.

At slower airspeeds, more rudder is required than at higher speeds.



When a glider is banked in a turn, the lift force which acts at right angles to the wings, rotates inwards to provide the inwards (centripetal) force to keep the glider turning. It's this force which keeps the glider turning.

When banked the vertical component of the lift is reduced. To prevent the glider sinking too much, the total lift has to be increased. This is done by increasing the angle of attack with an easing back on the joystick.

Because total lift is increased in a turn, G force or the load factor on the wings increases The load factor and stall speed goes up proportionally to the bank angle. In a 45^{o} bank, the load on a glider is 1.4 times normal or 1.4G and the increase in stall speed is 18% .

Excessive rudder can be dangerous. If more rudder is used than is necessary in a turn, the glider yaws, turning the fuselage sideways into the airstream. This increases drag, perhaps as much as if the airbrakes were opened and the glider loses speed and sink increases… very dangerous in the circuit because this can be the start what will eventually lead to a spin.

When thermalling, an angle of bank around 45° is normally recommended but the angle does depend on the conditions. You will probably climb faster with a shallower angle of bank in weak thermals. In rowdy thermals or narrow thermals low down, a tighter angle of bank is often required just to stay in the thermal without being thrown out.

It's claimed that tighter angles of bank are easier to maintain and the slight increase in sink may be compensated for by the longer time spent centralised in a thermal.

The glider's stall speed increases in a turn so airspeed has to be increased when banking. However this increase in airspeed makes the controls more effective and recovery from a stall is faster than in a slow and shallow turn.

This is why shallow turns in the circuit are to be avoided. In the circuit, bank angles should be at least 30°. Almost everyone underestimates the amount of bank they are using so if you think you are over-banking, it may not be so.

It takes some of us a while to properly coordinate every turn so if you are finding it difficult to remember which foot to press on the rudder when turning, take heart and don't give up.

You can practice getting your foot and hand coordination better with a chair and a broomstick. You can even practice while sitting in an armchair by pushing one foot downwards while pushing on the same-side arm of the chair.

If you are always using the wrong foot, you might also be reassured to know that in the early days of aeroplanes, the rudder pedals actually worked the other way… a push on the left foot would angle the rudder to the right.

Further effects of controls

When the elevator is moved in flight, the glider's pitch changes. That's the only effect of the elevator. However the two other controls, ailerons and rudder, have secondary effects.

A secondary effect of the ailerons is yaw. When banked, the glider will tend to slip inwards towards the lower wing. The vertical area of the fin and rear fuselage will then tend to yaw or weathercock the glider towards the lower wing.

When the ailerons are moved by the stick to roll the glider, the increased lift on the up-going wing causes more drag which will tend to yaw the glider out of the turn unless counteracted by the right amount of rudder.

A secondary effect of using the rudder is to roll the glider. Anyone who has flown an R/C glider with just elevator and rudder controls will know that it is possible to bank and even roll a model with just rudder alone. However, this is a technique which should never ever be used in full-sized sailplanes.

Due to a glider's large wingspan and the resulting adverse yaw effects, uncoordinated turns with excess amounts of rudder can lead to stall-spins. This is covered in greater detail in the spinning section of this manual.

Tow Cable Release

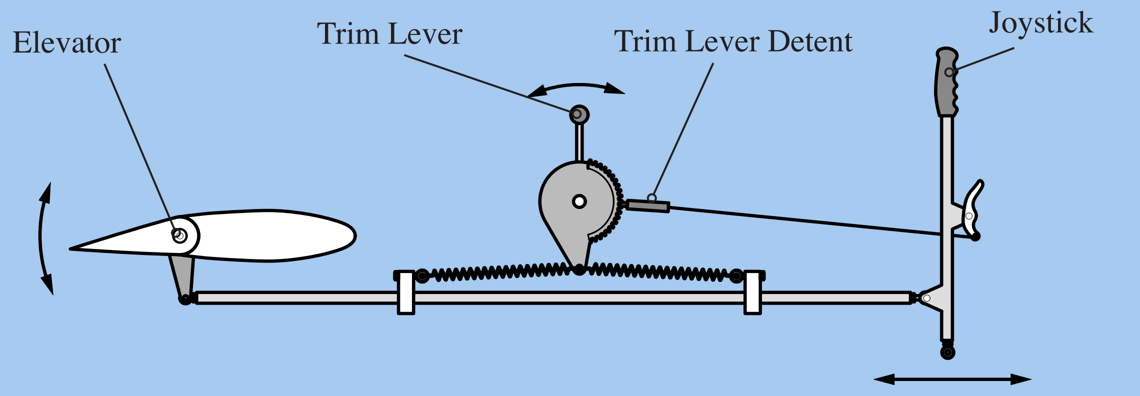
On all gliders other than self launchers, the glider is towed or winched into the air and releasing from that energy source quickly and safely is very important. The cable release is a yellow knob, either round or tee handled, placed somewhere close to the pilot's left hand.

Most gliders have two tow hooks, one for aerotow towards the nose of the glider and another belly hook installed in a position which makes it suitable for winching. The cable release operates both these hooks simultaneously.

Trim

By adjusting the trim control, the pilot can reduce the pressure on the joystick so that the glider will maintain a desired speed. This means that when thermalling or when cruising fast between thermals or flying a circuit, the glider will fly virtually hands-off at the set speed.

Note that it is the joystick and elevator which set the speed, the trim only serves to reduce the load on the joystick.



Functional diagram of a typical trim system

The trim control is normally a lever which can be moved fore and aft in a similar sense to the joystick. The trim lever's position is maintained by notches or friction and the control is always coloured green.

The trim control can be placed on the left cockpit wall or beside the joystick, where it is operated with the left hand or even on the right side of the cockpit.

On flapped gliders, it is common to have a mechanism built into the trim control which disengages the notch detent and allows the position of the flap lever to set the trim speed.

This greatly simplifies trimming since the flap position is set for a particular speed range. When the pilot sets the flaps, the trim is also set.

In most cases, the trim mechanism at the control end is a simple set of springs which apply pressure to the control rod running between the joystick and elevator.

On many training gliders, rather than adjust the angle of the entire elevator, there is a separate trim tab on the elevator directly controlled by the trim lever.

Airbrakes & Approach Control

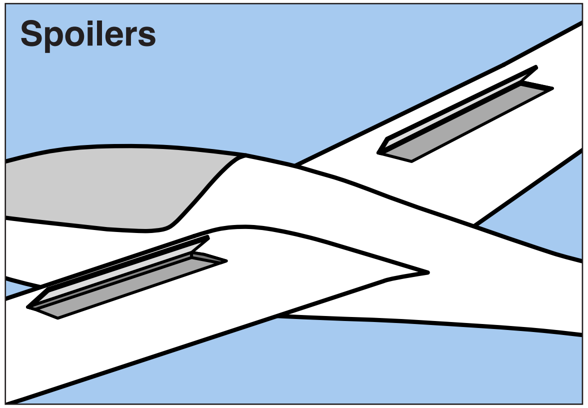
In a modern glider, it is essential to have an effective means of controlling the glide slope so the glider can be landed easily where the pilot wants and this is referred to as approach control. Approach control is done with either spoilers or airbrakes. The airbrake or spoiler control handle is always coloured blue.

On early gliders, a common method of approach control was sideslipping but since the first gliders descended like a brick, not much more was required. Sideslipping is still a good way of losing height in a rapid and controlled manner but it requires a lot more skill to sideslip well compared to using airbrakes.

As the performance of gliders improved methods of approach control were worked out including braking parachutes and spoilers. In fact, parachutes were not much of an improvement since they had a regular habit of not deploying at the right time making landings much more exciting than necessary.

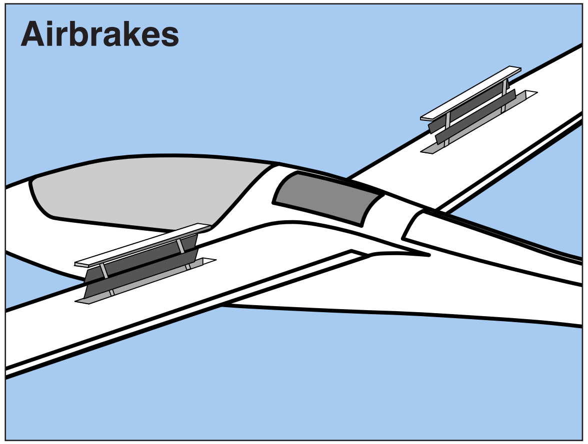
On one design of high performance glider, a tail parachute was the only method of approach control available… strictly for experts!

Spoilers use a simple system where a rectangular surface is levered out at an angle



into the airstream from the upper surface of the wing. This has the effect of destroying lift and therefore increasing the sink rate.

Modern gliders almost universally use airbrakes. Here, a rectangular surface is raised into the airstream from the upper surface of the wing and occasionally the lower surface as well.



Both spoilers and airbrakes can be easily and effectively adjusted to give easy and accurate approach control. The biggest advantage of airbrakes is that they are also speed limiting because they increase drag by a much larger amount than simple spoilers.

Because the design of approach controls has developed over the years, the effectiveness of one glider's airbrakes may be quite different to those of another type and it is important to read the flight manual and talk to other pilots who fly that type and make the first few landings in a conservative manner.

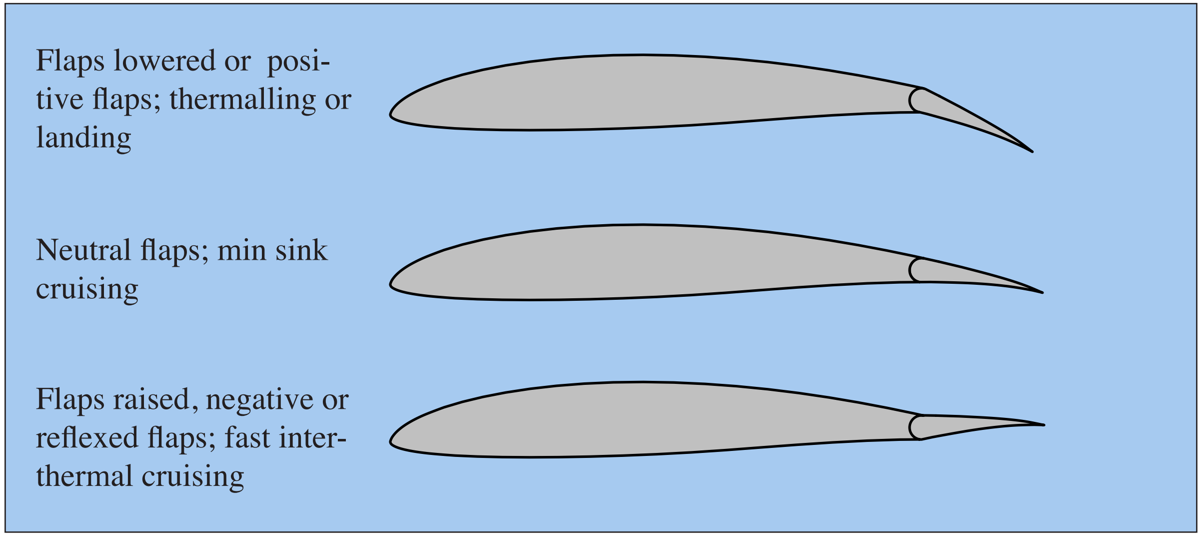
In the design of modern gliders there are a few approach control design requirements that must be adhered to. One is that airbrakes, when fully deployed, must give an L/D of less than 7:1. This reduces the performance of a sailplane to that of an early hang glider and allows the pilot a huge amount of control.

Another design requirement is that the airbrakes must not suck out. With some gliders, if the airbrake lever is not locked in the closed position, the airbrakes may be sucked out a small amount. This can be very dangerous if it happens during take-off and is one reason why airbrakes are locked and checked before takeoff.

Airbrakes can change the handling of a glider in several ways. Firstly, they can cause the stall speed to increase by 2-5 knots. In a circuit prior to landing, you should have enough speed to allow for this but it is another reason to maintain a safe speed near the ground, well above stall speed when airbrakes are deployed.

Secondly, airbrakes can cause a pitch change which may be nose up or nose down.

Because of these side effects, it is important to ease airbrakes out gently and be prepared for any pitch changes… and never violently pop airbrakes out while the glider is banked over at low altitude, when turning onto final.



Flaps

If you look at the specifications of gliders over the years, for a given wingspan and wing area, you can see that as performance has improved, the airframe weight has increased and so has the capacity of the glider to carry water ballast.

The term used for this is wing loading which is the all up mass of the glider including airframe, ballast and occupants divided by the wing area.

To some extent, the weight increase has been due to making the airframe stronger to handle increased speed but there's no doubt that increasing wing loading has gone hand in hand with performance gains.

The down side of higher wing loading is a higher stall speed which in turn means higher landing speeds with greater energy involved and this requires longer airstrips.

Before fibreglass took over as the preferred construction method, the last generation of training gliders had stall speeds around 32 knots. Typically, fibreglass trainers have a stall speed closer to 38 knots and higher performance single seaters have a stall speed of over 42 knots.

One way of lowering the stall speed of a wing while maintaining the higher end performance gains is to fit flaps. Flaps can be lowered to improve the lift coefficient and get a lower stall speed while thermalling or lowered even further to get a slower safe landing speed.

The increased drag is compensated for by the increase in lift and lowered stall speed. Flaps can also be raised for fast cruising.

Flapped gliders normally have a flap control operated by the pilot's left hand which can be notched into a series of detent positions. The positions are either marked in degrees or just a number… so one pilot might refer to having

"8 degrees of flap" while another will call this "a flap setting of 2".

On a typical high performance single seater, lowering flaps to full landing position will drop the stall speed from 42 knots to 38 knots… not a massive change but consider that on the same glider with full airbrakes, the stall speed is actually raised by 4 knots.

There are some differences when flying a flapped glider compared with an unflapped glider. One is that the tell-tale pitch changes used to evaluate your airspeed are much less because the position of the flaps tends to counteract the pitching moment of the aerofoil.

Another side effect is that with full landing flaps, the drag goes up and the glider's sink rate increases to an amount similar to having part-opened airbrakes. Consequently, the pilot must make a nicely judged round-out and flare when landing because even with fully closed airbrakes, the sink rate is quite high.

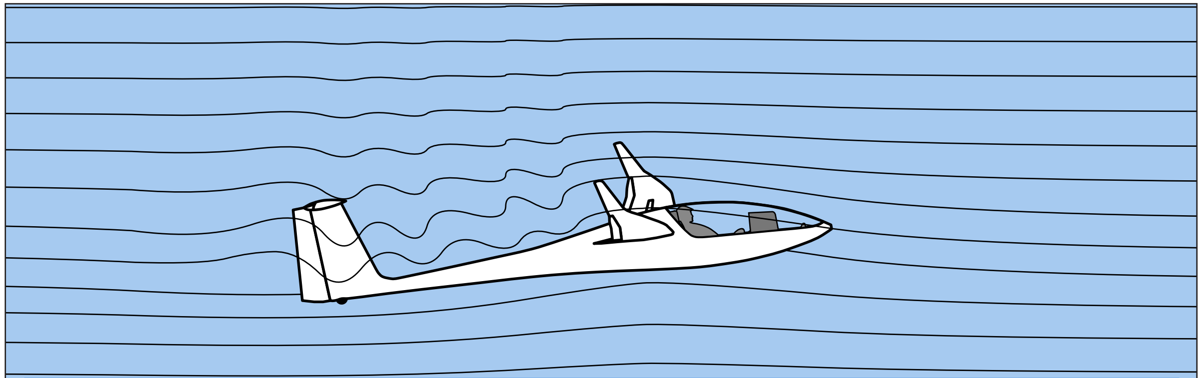
More importantly, if it looks as if you're undershooting on finals, you cannot just raise flaps to clean up the airflow and reduce the sink rate as you might by closing airbrakes.

The reason for this is that when you raise flaps, drag decreases, but so does the total lift and because there's less lift, the glider has to accelerate to regain the same amount of lift. The consequence of this is that if you go from positive flap to a more negative setting in a circuit, the glider actually loses height, right when this is the last thing you want.

Most flapped gliders use an aerofoil section optimised for flaps. Positive flap settings allow slower speeds for thermalling while negative flap settings can be used at high inter thermal speeds to reduce the pitching moment caused by the aerofoil and the drag caused by the elevator counteracting this.

However the performance differences between flapped and unflapped gliders are small… in some cases very small indeed but a flap control on a glider does give a pilot an extra lever and something to do with their left hand.

Stalling



A stall is caused when the wing exceeds its critical angle of attack and the airflow cannot remain completely attached to the wing. Around the stall angle, separation bubbles cause turbulent flow which hits the tail of the glider, causing tell-tale buffetting.

A stall occurs on a wing when its angle of attack is high enough that the air cannot smoothly flow around the wing. The high angle of attack causes the airflow to separate and form a turbulent separation bubble near the trailing edge. (Tailplanes are normally rigged at a lower angle of attack than the main plane so that they stall later.)

Initially, the separation bubble may be quite small but as the angle of attack increases, the bubble grows, lift drops and drag increases to the point where although the wing is still generating lift, it no longer generates enough lift support to the airframe in level flight.

The wings of gliders are designed so that a stall starts at the wing root. This is done by a combination of choice of aerofoil and what's called twist or washout where the angle of attack of the wing's tip aerofoil section is slightly lower than the root section.

It's important to realise that a stall is caused when the aerofoil has reached a critical angle of attack rather than a critical airspeed. It's convenient to talk about a stall speed because, apart from the attitude of the glider, we're not conscious of the wing's angle of attack. If we know the load factor or take-off weight of a glider, we can look up the stall speed in the flight manual.

However this will only remain true if the load factor remains constant. In straight and level flight the load factor is constant but as soon as the glider banks, the load factor increases.

Gliders fly in two main flight regimes, slow while climbing, and fast while cruising between climbs. In the slow flight regime, the glider is often flown so that the angle of attack of the wing is close to the stall.

This has two implications. The first is that most gliders are designed to have a very benign stall characteristic and very few indeed exhibit any nasty tendencies at the stall. The other is that glider pilots do stall training very early on in their training.

Stall Training

The first stage in stall training is learning how to recognise a stall, or rather an impending stall… what the pilot is doing on the controls to approach the stall, and what the glider feels like around this point. In straight and level flight, the controls will feel mushy and the attitude may be nose-high. There should be a pronounced buffetting felt through the stick from turbulent air around the tailplane.

If the glider is flying slowly and close to the stall in straight and level flight, the glider can be stalled just by initiating a turn.

Pre-Aerobatics Check List

Stalls are considered an aerobatic manoeuvre and at some point in your training, you'll progress from recognising a stall to a full stall, an incipient spin and a fully developed spin.

To make sure that you, the glider and everyone else is safe and ready for any aerobatics, there's a check list which is followed called the HASLL or HASSEL check list.

There are a couple of things to note. The first is that not all gliders are certified for spinning. All training gliders are otherwise they would not be used for training though some require spin kits to be fitted to allow them to spin. Touring motor gliders and most open class big wingspan gliders are not permitted to spin. Read the aircraft's flight manual before doing any aerobatics.

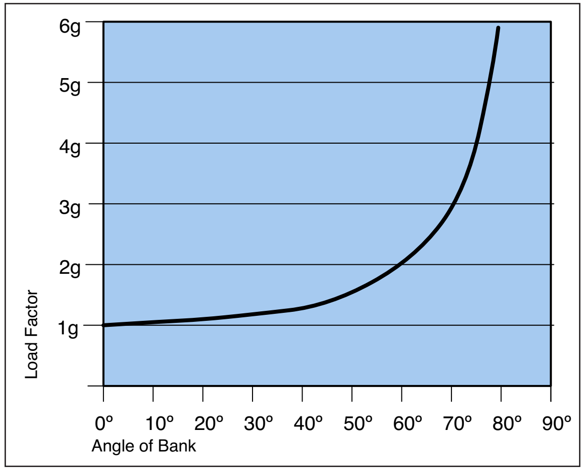
Another issue is that modern slippery glass gliders, especially those which are heavy and with big wingspans can lose a lot more height in a spin than most training gliders. For that reason, it's essential to make sure you've got enough height above the ground before practicing even a gentle stall.

Pre-Stall, Spin & Aerobatic Check List

HASLL check list

H Height	Aerobatic manoeuvres should not be started without making sure that you have enough height to recover fully to a normal flight by 1,000' AGL. Modern, slippery and heavy gliders will require more height than light, draggy gliders.
A Airframe	Flaps, airbrakes, undercarriage and trim should be set correctly. Importantly, the airframe should be certified for the intended aerobatics. Not all gliders are certified to spin or perform other aerobatics.
S Security	Make sure that harnesses are secure and all loose items in the cockpit are securely stowed. Make sure the canopy, vents and hatches are securely closed. In two seaters, the harness of unoccupied seats must be secured so that it doesn't interfere with controls.
L Location	You should be clear of other aircraft, cloud, built-up areas and busy airspace near aerodromes while doing aerobatics.
L Lookout	Before beginning aerobatic manoeuvres, do a 180° turn in one direction followed by a 90° turn in the other direction to make sure that the airspace nearby, above and below is clear.

It's a good idea to give a radio call to let other aircraft in the area know what you are doing.



As the glider is banked into a turn, the load factor or 'g' increases. At a bank angle of 20°, the load is about 1.1 times normal. At 30°, the load factor is about 1.2 and at 45°, perhaps a more normal bank angle for a glider, the load factor is 1.4 g.

This increase in load factor is because the lift generated by the wing acts at right angles to the wing and when the glider banks, the lift vector is rotated too but the weight of the glider still acts straight downwards. To counteract this and maintain height, the angle of attack of the wing must increase to increase the lift.

The pilot pulls back on the stick to increase the angle of attack, and if not checked, once the critical angle of attack of the aerofoil section has been reached, the wing will start to stall.

At the point of the stall, drag increases more rapidly than lift. The combination of drag and loss of lift causes the wing to drop and the glider enter an un-commanded turn or auto-rotation. If the auto-ration is not stopped, the glider will enter a spin.

With a well designed wing, the stall will start at the wing root and only gradually move outboard so control is maintained and the pilot has a chance to correct the stall. However if the angle of attach increases rapidly, the stall will also happen rapidly.

It is fairly easy to recognise the signs of an approaching stall in level flight because the stick is normally back and the nose is normally above the horizon but it's not so easy to detect an approaching stall when banked over when thermalling or in the circuit. The attitude of the glider may not appear to be nose-high though the stick will always be back causing the angle of attack to be close to the critical angle.

In a properly banked turn, the airspeed is higher so there's more control authority and a recovery from an incipient stall or wing drop is normally very rapid. If the controls feel waffly in a turn, that's a sure sign of an approaching stall.

Stall recovery

In essence, stall recovery is easy. Since a stall is caused by a too-high angle of attack, **easing the stick forward to lower the nose and reduce the angle of attack will cause the airflow to reattach to the wing and the glider to recover from the stall.**

Since gliders are slippery aircraft, the stick normally needs only to be eased forwards. However, how fast this easing is will depend on the glider and flight regime the glider is currently in.

Lower performance gliders with higher drag will need more stick movement than high performance, low drag gliders. If airbrakes are out at this stage, the stick may have to be pushed forwards faster and further than if the glider is clean.

This last item is an important point to bear in mind. If you are about to land and turning onto finals with airbrakes open (not recommended) or flying too slow on finals with airbrakes open, you will need to act faster to get the stick forwards and leave it forwards for longer to allow the glider to accelerate to a safe airspeed to stop a stall. Closing airbrakes will let the glider accelerate faster to a safe speed.

Recognising a stall

Because stalls are related to angle of attack, the first sign of an impending stall is often that the nose of the glider is slightly higher than normal. While this may be easy to see in straight and level flight, it takes longer to recognise in turning flight. There are a number of other tell-tale signs.

When approaching the stall, the centre of pressure of the wing moves backwards and the glider's nose will tend to drop. To maintain a this high angle of attack, you have to be holding the stick back.

At the stall, the elevator no longer has any control authority and the stick will normally be back in your lap and will no longer raise the nose or stop it falling.

As the angle of attack increases and the stall progresses, stick forces get lighter and control authority reduces. It's a design requirement of modern gliders, that good control authority exists well beyond the stall but you can feel the stick getting light and control becoming waffly.

A glance at the ASI will show you that the airspeed is low.

As the airspeed drops, things get quiet. This may be true but it can be a fairly unreliable sign of a stall since most gliders are quiet at thermalling speeds but it's something you're often aware of after the stall when you're thinking over what just happened.

It's a design requirement of modern gliders that there must be a clear and distinctive stall warning. The turbulent airflow from the semi-stalled wing hits the tail of the glider and this buffetting can be felt through the rudder pedals or the stick. If you're using airbrakes and the undercarriage is down, it can be difficult to sense the buffetting and things may not be quiet.

If a glider is slowly brought to a stall in straight and level flight, the stick will usually be well back or even fully back against the end stop when the glider is stalled. *This is the only one of the above indicators which is present in all stalls*.

Mushing stalls

It's possible to bring the stick back slowly so that the wing never fully stalls and the glider mushes forwards with the high drag of the semi-stalled wings causing a high sink rate.

The ailerons and elevator may still have a degree of authority but both wings will be at a high angle of attack and close to the stall. Noise levels may be higher than in a faster stall and if there's a bit of sideslip, the ASI may be reading high or low.

In fact, this is a typical situation which may occur when the glider is making the turn from base to the final leg when landing, if you're low and try to flatten and prolong the approach by easing back on the stick.

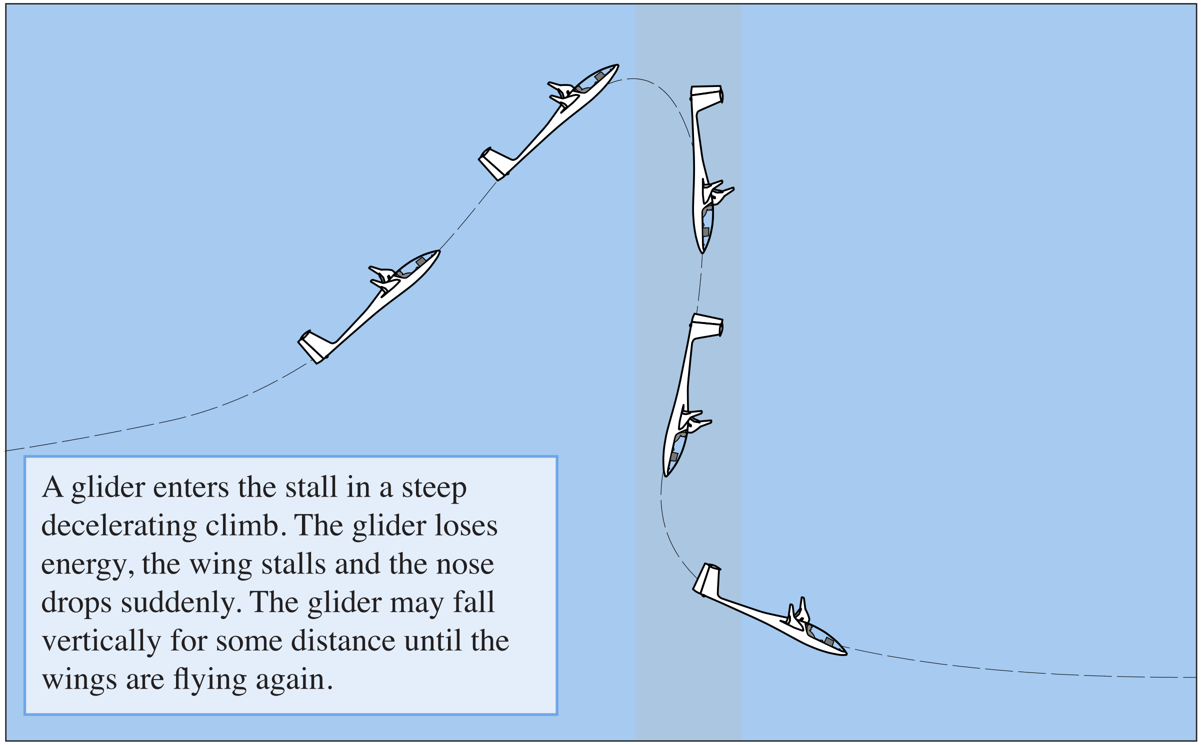
The risk here is that if that turn is uncoordinated with excessive rudder, this causes the glider to yaw into the turn and the reduced airspeed over the yawed side wing may cause a full stall on that side. The wing drops and the glider enters a typical stall-spin with little height for recovery. ***This is why it's essential to make coordinated turns and maintain a safe speed above the stall when close to the ground at all times***.

Winch launch stalls

If a winch cable breaks during a winch-launch while the glider is climbing at a steep angle, the glider will rapidly decelerate and the airflow will reduce over the wings. If the glider is not pushed nose down very rapidly, there's a significant risk of a stall. The time available to get the nose down is very short… possibly under two seconds. *You must always anticipate a cable break when winch launching.*

If the glider is nosed over quickly, the G loading reduces on the airframe. Because of this, the wings are not required to support as much load and the risk of a stall is momentarily less. As soon as the nose-over ends, the load comes back on the wings.

Throughout the cable break recovery, it is essential to keep the nose down and the glider accelerating. Any attempt to turn may yaw the wings and cause a stall-spin. The nose should be held down until the airspeed reaches a safe value (i.e. 1.5 Vs) when the glider can be safely manoeuvred and landed normally.



A glider enters the stall in a steep decelerating climb. The glider loses energy, the wing stalls and the nose drops suddenly. The glider may fall vertically for some distance until the wings are flying again.

High speed stalls

Since stalls are related to angle of attack, it follows that a wing may also stall at higher speeds such as may happen if a glider is pulled up too sharply from a high speed dive. The G from the pull-up increases the wing loading and the angle of attack goes up to provide the required lift. If the critical angle of attack is exceeded, the wing stalls.

There's another type of stall which can happen if a glider is zoomed into a steep climb and held there until the wing stalls… the high speed stall.

If the glider is close to vertical at the top of the climb, the glider may go into a tail slide. Glider rudders are not designed for the heavy loads involved in this sort of aerobatic manoeuvre.

High speed stalls should never be done deliberately.

Some pilots practice stalls and spins when familiarising themselves with a new glider type but you should never practice high speed stalls.

Most but not all gliders are approved to do simple aerobatics such as spins, inside loops, lazy eights and chandelles without water ballast. Spins are not a permitted manoeuvre for all gliders. Read the flight manual to see which manoeuvres a glider is approved to fly.

Spins

Before going into a discussion of spins, it worth pointing out that for a lot of their air-time, gliders fly close to the stall and spins are very rare. Most modern gliders, provided they are flown in a properly coordinated way, above the stall and within their approved weight and balance range, are quite difficult to spin and will recover easily with little loss of height, so spins don't perhaps deserve the bad reputation they have with the general public.

In Australia, all glider pilots are trained in stall and spin awareness, recovery from incipient spins (the stage between stall and full spin) and fully developed spins. Spin recovery is also checked during Annual Flight Reviews.

Spins begin with an asymmetric stall. One wing stalls, or stalls more completely than the other, the stalled wing drops due to loss of lateral damping and the glider begins to auto-rotate around the stalled wing in a stable manner. A fully developed spin is a stable manoeuvre and a glider will remain in a spin unless the pilot stops it.

Instructors seem to like spinning more than students, mainly because they want to teach an active and effective spin recovery procedure. On the other hand, most two seat trainers commonly in use are quite difficult to spin and once the rudder is centralised, will generally recover with little pilot input other than moving the stick forwards.

The problem with this situation is that it's difficult to know whether the student piloted the spin recovery or that the glider did it by itself and for this reason, student pilots often get a lot of experience at recognising the onset of a spin, known as an incipient spin, rather than a fully developed spin.

Re-entering spins

When reading the following and when practicing spin and incipient spin recovery, you should remember that at the point of a stall, a wing drop could go either way due to the loss of lateral damping from a stalled wing.

A big point in spin training is getting a feel and familiarity with both spin entry and recovery so that the right amount of control is used to recover as quickly as possible. This means recognising the direction of the spin and using the opposite direction rudder pedal.

Incipient spins

Technically, an incipient spin starts with an asymmetric stall which is followed by a wing drop or auto-rotation caused by the stall progressing along the wing. This is true of all spins, whether started from level flight, a turn or even from inverted flight. If you recognise an incipient spin and correct it smartly, a fully developed, stabilised spin does not develop.

A dropping wing can normally be corrected very quickly by easing the stick forwards a little and putting in enough opposite rudder to prevent the glider yawing towards the dropping wing. As the rudder yaws the glider, the airflow over the dropping wing increases, adding to the effectiveness of the ailerons.

Across the stall condition, airflow over the glider's control surfaces is not enough to give full control authority but the controls will still work. Most gliders still have some aileron authority at the stall but don't use ailerons because that itself may cause the glider to enter a spin. At the stall, the rudder works almost normally. The elevator will work if the stick is pushed forwards but in a normal stall, the stick is almost fully back and therefore there's no more up-elevator movement possible.

If a dropping wing is not corrected immediately, or if the wrong direction of rudder is applied, the glider will enter a full spin.

Spin recovery sequence

The spin recovery sequence is standard for all types of gliders. Although it is listed as a sequence, the initial stages are normally done fairly rapidly in close order.

- Apply full rudder in the opposite direction to the spin.
- Centralise the ailerons to stop any bank.
- Move the stick progressively forwards until the rotation stops.
- When the rotation stops, centre the rudder and roll the wings level.
- Ease the stick back to pull the glider out of the dive.

It may take a moment to identify the direction of the spin before using full opposite rudder.

By this time you are looking at a lot less sky than a few seconds before, the view outside may be unusually green and brown and there's often a powerful and instinctive reaction to continue to hold the stick back. Don't! Move it forwards. You may have to make a strong conscious effort to move the stick forwards due to the unusual amount of ground that you're looking at. In most gliders, releasing the back pressure on the stick may be enough but in others you may have to ease the stick progressively forwards until the rotation stops.

If the CofG of the glider is aft, the glider may have a more nose-up attitude when spinning and the stick may have to be pushed further forwards to recover from the spin.

Typically, the nose of T-tail gliders will oscillate up and down when spinning, sometimes violently but they'll recover normally using a standard spin recovery procedure.

When that's done, most gliders will pop out of the spin rapidly and the aircraft's positive pitch control will by itself start to recover the glider from the dive.

The rudder helps to slow the speed of rotation but it's stopping the bank and reducing the angle of attack on the wings which will stop a spin. Once both wings are un-stalled and 'flying', roll damping will stabilise the aircraft.

It's important to follow the spin recovery sequence and make sure that the stick is centralised before starting to pull out from the dive. If a glider is not coming out of a spin, think about what you are doing wrong.

A few complications may occur when recovering from a spin. One is that your spin recovery is too rapid. The glider stops rotating and if your movements with the stick to correct the bank and pull the glider out of the dive are too fast or too far, it may cause the glider to promptly enter a spin in the opposite direction… of course this does give you the chance to do a better recovery next time.

Another issue is that the initial attitude of a glider in a spin can vary a lot, from a modest dive to something beyond the vertical. This is mainly dependent on how the spin started and the design of the tailplane.

When a glider enters a stall slowly from more or less straight flight and the initial asymmetric stall is slow, then the glider may enter a spin quite slowly.

On the other hand, if a wing stalls rapidly and completely, the wing drop may be fast enough that the glider rolls over beyond the vertical. This means that when you've stopped the spin, recovering from the dive will take longer.

These factors may all be present in a stall-spin during a landing approach. In this situation if possible, airbrakes should be closed immediately and flaps put in a neutral position.

So for all these reasons, stop a spin as smartly as you can.

Remember, spins are not an approved manoeuvre for all gliders and gliders carrying water ballast should not be spun intentionally.

A spin should always be stopped as soon as possible.

All certified (CS 22) gliders are capable of recovering from spins using normal spin recovery technique *provided that they are flown within their design weight and CofG (centre of gravity) limits*. That's why it is essential that aircraft are properly ballasted in accordance with the placards or Flight Manual.

Spins which are allowed to develop will take a lot longer to recover from because of the build-up of angular momentum.

If a heavy or long wingspan glider is allowed to develop full rotation, it will take longer to stop than a light weight glider. With a light pilot and a CofG aft of design limits, some gliders may not recover from a fully developed spin.

A slippery high performance glider will enter a spin more quickly than a training glider.

Fear of spinning

There's no doubt that for many people, spins are towards the top level of excitement they were looking for while gliding but a little too much excitement is as far as most spinning goes.

Many instructors spend a disproportionate amount of their flying life spinning and can forget that the rest of us don't! If you are nervous about spinning, then are there two things to do.

1. Tell your instructor about this before spin training. You can then start gently and build up confidence in the manoeuvre going from incipient spins to the real thing.

2. Practice incipient spin recovery as much as you can so that you recognise the start of a spin and recover quickly and smartly. This way, you need never get into a spin.

Spiral Dives

Gliders which enter a spin in a nose down attitude may go into a spiral dive. Spiral dives are more likely to happen when the CofG is forward. Recovering from a spiral dive is fairly easy but the procedure is not the same as when recovering from a spin so it's essential to understand the differences between a spin and a spiral dive so that the correct procedure can be applied.

The main differences between the two are that in a spin the G force are not high and the elevator is ineffective. In a spiral dive, the G force is increasingly high and the controls work normally, allowing you to fly the glider out of the spiral dive.

Spiral Dive	Spin
• Rapidly increasing rate of descent.	• Constant rate of descent
• *Increasingly high G forces*	• *Low G forces*
• Airspeed increases	• Airspeed more or less constant
• Increasing bank	• More or less constant bank
• A high rate of turn will have large G forces	• A high spin rate may have low G forces
• *The controls work normally*	• *The ailerons are ineffective.*
• Pulling the stick back increases G loading	• Pulling the stick back does nothing

Recovering from a spiral dive

- Ease the stick forward to reduce the 'g' force, and then apply rudder and ailerons to roll or bank out of the turn. This will put the glider into a conventional dive.
- Gently pull the glider out of the dive by easing the stick back.

The differences between a spiral dive and a spin are noted alongside. Either is easy enough to recover from but you need to use the correct technique for each. If you try to roll out of a spin, nothing will happen and kicking in rudder in a spiral dive may overstress the glider.

In a spiral dive, you must get the wings level before pulling the stick back because pulling back on the stick will increase the rate of turn and the G forces involved.

Be aware that in many high performance gliders the pilot is close to supine when flying and it's more difficult to feel G forces than when sitting more upright.

Self-Test Questions

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

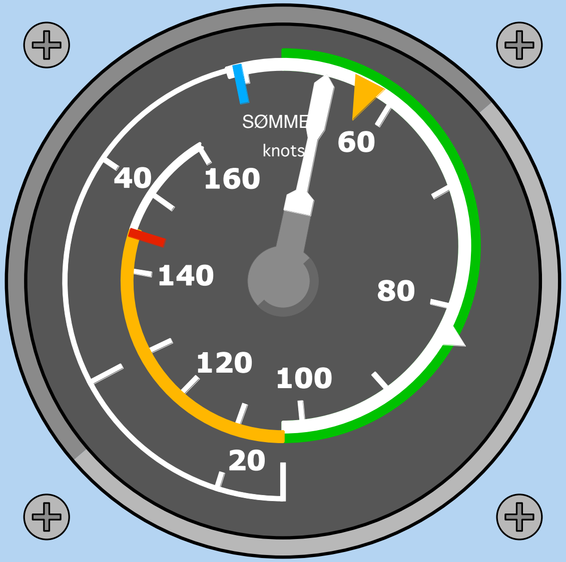
1. What is the name given to the cross-sectional shape of the wing?
2. What three factors affect the lift produced by the wing?
3. In what direction does lift act?
4. Define wing-loading.
5. Name the two kinds of drag.
6. What provides stability in the pitching plane?
7. What is dihedral and what is its purpose?
8. What is the speed control in a glider?
9. What are the controls for turning?
10. What is adverse yaw and what causes it?
11. Define "coordination".
12. What is the secondary effect of the rudder?
13. What is the purpose of spoilers or airbrakes?
14. What happens to the stalling speed when flaps are lowered?
15. What action must never be omitted before turning?
16. What are the symptoms of a stall in straight flight?
17. What action must the pilot take if the glider stalls?
18. Is it possible to stall in a turn without a nose-high attitude?
19. What action must the pilot take if the glider stalls in a turn?
20. What is the recovery action from a fully-developed spin?
21. Define "safe speed near the ground". Calculate the speed to fly the circuit in a glider which stalls at 33 knots in straight flight.
22. How would you know if you had not applied enough rudder with aileron at the entry to a turn?
23. What is meant by the term "auto-rotation"?
24. 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?
25. What is another name for directional stability?
26. Define aspect ratio.
27. What kind of drag is affected by a change in aspect ratio?
28. Which force provides a glider with forward speed?
29. What happens to the stalling speed when the airbrakes are opened?
30. What does L/D stand for?

Instruments

In spite of the fact that the panels of many modern gliders are stuffed full of instruments, you don't need many to fly a glider and only three are mandatory. Gliders are required to carry a mechanical Air Speed Indicator (ASI), altimeter and compass. The ASI measures the pressure at a forward facing tube in the airstream called the pitot tube. The altimeter indicates the static air pressure around the glider.

The construction of these two instruments is quite similar since they both use an aneroid barometer capsule to measure pressure. The capsule is connected to the needle of the instrument by a series of levers and small gears, much as you might find in an analog watch or small clock which amplifies the relatively small movement of the capsule under the influence of air pressure.

Because of their mechanical construction, both instruments are delicate and require great care. In the Daily Inspection (DI), the ASI is checked to make sure that there are no blockages such as dirt or insect's nests in the tubing by blowing across the pitot head. The ASI can be damaged if this is done incorrectly, so make sure you have been shown how to blow near a pitot head before doing it and correct anyone who you see blowing the wrong way.



Air Speed Indicator (ASI)

Air Speed Indicators are usually marked at critical speeds in the aircraft's operating envelope which are noted in the flight manual.

White Arc: Positive flap operating range

Green Arc: Normal operating range. (VA)

Yellow Arc: Manoeuvres must be conducted with caution and only in smooth air. (VRA)

Red Line: Max. speed for all operations (VNE)

L: Max. speed in landing configuration.

Blue Line: Speed of best climb (SLGs).

Yellow Triangle: Approach speed at max. weight without water ballast.

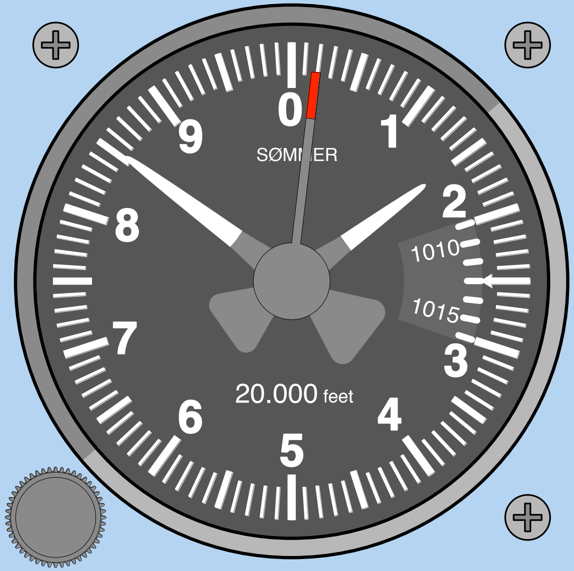
Air Speed Indicator

The Air Speed Indicator or ASI is perhaps the most important instrument in the panel and as such, most are the larger 88mm instrument size and placed towards the top of the panel where they can be easily seen and quickly checked.

An ASI is essential for flying a glider because without it, we'd find it difficult to make sure we were flying at the right speed. In Australia the scale on the ASI is marked in knots. The dial also has colour coded arcs to show critical ranges of airspeeds for a the glider including the normal operating speeds, the rough air manoeuvring speed range, and if the glider has flaps, the maximum speed for positive and landing flap operation.

There are usually markings on the face of the ASI in different colours to indicate speeds such as the maximum airspeed (Vne), the maximum speed in landing configuration and best climb speed. Because these speeds and markings vary from glider to glider, it's something to check in a glider's flight manual before you fly.

At sea level, ASIs should read correctly. With greater altitudes, due to decreasing atmospheric pressure, the ASI under-reads true airspeed by about 1.5% per 1000’, so at 20,000’ the error can be more than 20 knots. It is important to understand the reasons and consequences of this error. It is covered in the True Airspeed and Indicated Airspeed section of this manual.



Altimeter

Altimeters have two or three needles on the dial. The largest needle indicates 1,000’ for one 360º sweep of the dial, so each lesser marking on the dial corresponds to a 100’.

The next smallest needle indicates 10,000’ for each 360º sweep and the smallest needle, if fitted, reads 10,000’ for each lesser graduation.

The knob on the altimeter is used to set the correct altitude before take off and can be used with the sub-scale dial to set the local atmospheric pressure in hectopascals.

Altimeter

Gliders are fitted with mechanical altimeters. These also use an aneroid capsule to indicate altitude rather than barometric pressure and in Australia the dial is marked in feet. There are normally two and sometimes three needles on an altimeter like the hands on a clock face. The largest needle indicates 1,000’ with one 360º sweep of the dial.

The next smallest needle indicates 10,000’ with one sweep of the dial and if fitted, the smallest needle indicates 10,000’ per major division of the dial. Most altimeters can read 25,000’ to 30,000’ but may only be designed or calibrated to be accurate to a lesser value.

There’s a knob at the side of the instrument which is used to set the current local surface pressure (QNH). The knob is normally used before take-off to set the altimeter to correctly indicate the known height of the strip. There’s a discussion of QNH in the navigation section of this manual.

Altimeters fitted to gliders are normally made for powered aircraft. This is worth remembering because the needle may be slightly sticky in a glider. In a powered plane, vibration from the engine will normally unstick the needle. Without this vibration, a gentle tap on the panel near the altimeter in a glider may cause the needle to jump a couple of hundred feet.

This is not to say that you should make a habit of tapping your altimeter, but if you are joining circuit a little low one day, losing a few hundred feet when you tap the panel might give you a bit of a scare. Get into the habit of estimating your height above ground in the circuit with your eyes rather than using the altimeter!

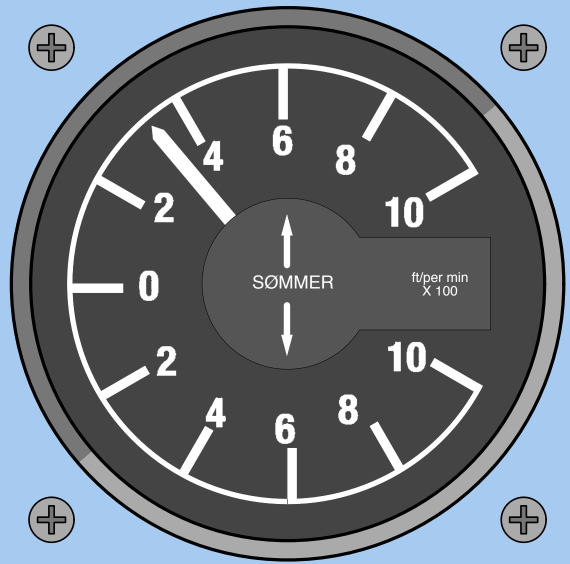
Compass

Gliders are legally required to be fitted with a simple magnetic compass which has been adjusted for magnetic deviation in the glider.

Few pilots fly using a map and a compass these days because GPS is so much easier and more accurate, but that being said, you should know how to fly to a compass bearing.

Mostly, you don’t fly by constant reference to the compass itself. You line the glider up onto the right bearing and pick some feature in the landscape aligned to the bearing and steer to that, occasionally checking the compass dial. When the landmark gets closer, you pick another mark, further away and repeat the process. Apart from being an easier technique, it avoids keeping your eyes looking inside the cockpit for any longer than necessary.

Compass dials are often difficult to see and may swing excessively during flight, sometimes because the damping fluid has dried up. The reading may contain errors due to magnetic variation, compass deviation and poor compensation. If this is the case in the gliders you fly in, make sure that the batteries are charged and that you have a reliable GPS… and get the compass fixed!



Variometer (Vario) - mechanical

A variometer or vario has a single needle which on the ground points horizontally towards the zero centre mark.

On a mechanical vario, the needle is un-damped and can move rapidly, flickering wildly in gust conditions while moving more smoothly in a thermal.

This can make the mechanical vario very useful when finding thermals compared with a damped electronic vario which may respond more slowly to changes.

Variometer

The most useful instrument when soaring is the variometer or vario which shows vertical speed or rate of climb or sink. A vario is similar to the rate of climb indicator in a power aeroplane but much more sensitive. As discussed in the section on thermalling, your senses will tell you when you start to climb, but not how fast you are climbing or sinking. The vario indicates that. It is not a legal requirement to have a vario fitted to a glider but most gliders will have at least two, one mechanical and the other electronic.

Mechanical varios work by measuring airflow in and out of a rigid insulated container such as a vacuum flask referred to as a “capacity”.

As the glider climbs, the air pressure outside the glider gets lower than the air in the flask and air flows out to equalise the pressure. The vario measures the rate of this airflow on a dial indicating climb or descent with a zero centre mark.

Electronic vario use a solid state pressure sensor which is designed to be unaffected by changes in temperature. The dial is either an LCD display or a needle driven by an electric stepper motor.

Electronic varios are able to filter out many of the errors present in a mechanical vario but both are connected to and dependent on the pneumatic plumbing on a glider. If this is blocked or plumbed incorrectly, your vario will not be nearly as useful as a well plumbed and compensated vario.

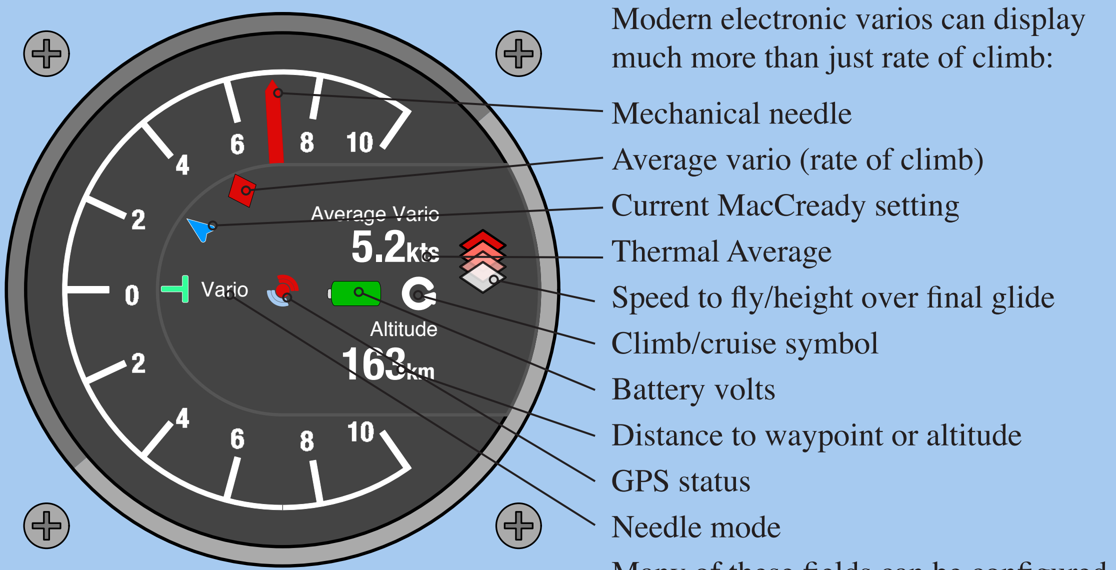
Electronic varios can have software compensation for many errors and can have features like software controlled averaging so the pilot can adjust the response rate and average time to suit their flying style.

Advances in transducer technology and falling prices has meant features like 3 axis accelerometers, 3 axis gyros and GPS are now fitted to everything from toy level RC aeroplanes and quadcopters to mobile phones and varios. The result is that the latest varios can use more than just air pressure to give rate of climb and can filter out errors due to horizontal gusts and wind.

Netto and Total Energy

If you are flying along and move the stick forwards or back, the glider will dive or climb. A basic vario shows this as lift or sink though you are not actually in vertically moving air... the glider is not gaining any energy from being

Modern electronic varios can display much more than just rate of climb:



Variometer (Vario) - electronic

Many of these fields can be configured by the user to show different variables.

in a thermal. This ‘stick thermal’ error can be corrected with some clever plumbing called total energy compensation. Varios with total energy compensation have their connections to the outside air arranged to minimise indications of stick induced sink or climb.

A total energy compensated vario will still indicate sink when a glider is flying along in still air because the glider is descending at its normal sink rate. It would be better to have a vario reading without taking into account the normal sink rate of the glider so that when flying in still air, the vario would indicate zero. The Netto vario does this. Again, this is done by intelligent connections in the mechanical plumbing or air connections to the vario.

The catch is the clever plumbing itself. There are many ways in which the mass of tubing connecting the instruments in a glider can get blocked by dirt or insects, kinked or crack and leak. Since varios are so important to glider pilots, if a vario is misbehaving, ask a Form 2 inspector to help you check the plumbing.

This instrument panel is from a self launching glider and has engine controls as well as the legally required and essential soaring instruments.

The ASI is the largest mechanical instrument at the top left of the panel.

The colour navigation and glide computer is centrally placed. Just above is the placard showing airspeed indications corrected for altitude.

A small FLARM display sits above the electronic vario. FLARM warnings are also displayed on the glide computer and announced through a speaker.

The engine controls sit below the main flight instruments.

Below the engine controls are the altimeter and mechanical vario.

The next row down is fitted with a stopwatch and mechanical compass.

A radio is fitted below the compass (out of frame). The radio's press to talk switch is on the top of the joystick.

A flip book containing check lists and essential radio frequencies is velcroed to the top of the instrument panel. Beside this is a mirror to check the engine and propellor position when raised.

MacCready Ring

When gliding restarted after the second world war, a number of complex mathematical theories appeared for calculating how fast pilots should fly between thermals to optimise speed and distance across country.

Speed to fly is based on the strength of thermals, specifically on the strength of the next thermal you are likely to meet but the calculations to work out speed to fly were difficult for most people to work out and apply in flight. It was all made easy, quick and practical when American Paul MacCready invented a simple indicator ring which fitted outside the vario dial.

The ring could be rotated by hand to indicate a speed to fly based on the anticipated strength of the next thermals. This worked so well that it helped MacCready win the world gliding championship and soon almost everyone was using a MacCready ring and discussing speed to fly in terms of a MacCready ring setting.

MacCready didn't invent speed to fly theory but he made it very easy to implement and as a result, speed to fly theory is now commonly called MacCready theory. MacCready theory is covered elsewhere in this manual, but what's important to understand here is that you need to know your average rate of climb in a thermal, bottom to top, to make MacCready ring settings work properly and this is difficult with mechanical varios.

Most modern electrical variometers use a single solid state pressure transducer as their main sensor. These sensors are fast, accurate, tiny, well compensated for changes in temperature etc. cheap and very reliable. For that reason they are in almost all cases used as the main vario in a modern gliders and real MacCready rings are rarely fitted.

This pressure transducer chip can be used to output both absolute altitude and rate of change of altitude as well as average rate of climb. In many cases, the average rate of climb can indicate more than one value, for example the average over one circle and the average of the whole thermal.

In almost all cases, electronic varios are connected in parallel to the same plumbing that mechanical varios use, so they are equally at risk of inaccuracies due to plumbing problems such as kinks, water or mud wasp debris in the tubes.

Electrical varios have many other advantages over mechanical ones. Perhaps the best is that they have an audio indication of climb or sink. Pilots soon become attuned to the sound and response of a particular vario.

You don't have to look at a dial to know what's going on, the vario sound becomes connected to your control inputs so thermalling can become almost instinctive, while your eyes are keeping an active lookout outside the glider. But why stop there?

Glide computers

With a solid state pressure transducer and a microprocessor or small computer, its not difficult to build a small electronic device, load it with data about the glider's performance and display far more than just altitude and rate of climb. Add a GPS and you have a complete glide computer.

Add more modern sensors such as the accelerometers and rate sensors commonly found in mobile phones and smart watches and you can have more computing power than the first lunar landers had!

Glide computers vary a great deal in performance and features. Some devices have simple monochrome LCD displays which use very little battery power and are always sunlight readable. Other instruments have high resolution colour screens featuring detailed moving map displays showing airspace, FLARM and other powered aircraft information.

Many pilots fly with GPS equipped portable computers, mobile phones and tablets running apps specially developed for gliding which are not built in and can be easily moved from glider to glider.

Wherever you fly, a glide computer can display the bearing, distance and required height to get back to your home strip as well as the bearing, distance and radio frequencies of airstrips, airports. Glide computer can automatically switch speed to fly and vario displays and sounds between cruise and thermals. Glide computers will automatically switch secondary displays between rate of climb and sink rate in thermals as well as altitude and distance to the next waypoint.

The huge advantage for almost all pilots is that an enormous amount of information is easily available in a form which doesn't require complex calculations or messing about with paper maps which might be difficult in times of stress. In other words, your situational awareness is greatly enhanced.

Few would attempt a serious cross country flight now without a working glide and navigation computer.

MacCready settings

Glide computers can display the average rates of climb sampled over 30 seconds, the current thermal bottom to top and the last few thermals. A suitable MacCready setting is continuously calculated which can be accepted or changed with a couple of button presses.

Final Glide

Glide computers have data on the performance curves (polars) of many gliders stored in memory. Given the glider's height above ground (most glide computers have a terrain database) and averaging the climbs and glides over the recent past, the glide computer can easily calculate how much height you need to get back to the strip.

When you are above or below this height on a task, the glide computer can tell you and give you an accurate indication of your final glide performance.

Voice Assistance

Many modern glide computers are fitted with voice assistance. Just like an in-car GPS and transport jets, the glide computer can talk to the pilot.

Typical information and warnings include:

- Warnings to raise and lower the undercarriage
- Warnings about airspace and with Flarm integration, warnings about other glider traffic.
- Notification that waypoints have been rounded or that you have enough height for final glide.

Moving Map Displays

Glide computers fitted with moving map displays have even more capabilities.

• They can be loaded with hundreds of waypoints and details of aerodromes and outlanding strips.

• Aerodromes can have a picture attached with details of runway length, direction, altitude and local frequencies etc.

• The recent history of your flight can be shown as a "snail trail" coloured to display lift and sink on track and as an aid to centring thermals and finding lost ones.

• A display to show the strongest and weakest parts of a thermal around the circle.

• Airspace can be shown with displays and warnings of possible airspace violations.

• Where a terrain database is loaded, the glide computer can give you information about possible collisions with ridges, mountains and towers.

• When interfaced with common gliding software such as SeeYou, the glide computer can be used for task planning and modification in flight.

• A compete set of task statistics can be displayed in flight to optimise your flight.

• If you are flying cross-country and running out of height, information and bearings to a number of strips can be displayed.

• Maps can be zoomed in or out to show details or whole tasks.

• Map pages showing task points or distance and bearing to alternative waypoints or your home strip can be switched instantly.

• Screens or pages can be customised in many ways to suit your preferences and display the information you want to see.

Glide computers with data loggers are not expensive and can add enormously to the fun of gliding, both in the air and on the ground after the flight.

Good airmanship requires that you should have an accurate idea of the facts and you should not rely solely on instruments like GPS and glide computers. They should be an aid to flying and navigation and not your only tool.

You should never use electronic instruments to the detriment of the basic airmanship skills of aviate, navigate, communicate. GPS should not be used as a primary means of navigation, especially not for avoiding controlled airspace. Visual pinpointing and official charts remain the primary legal means of cross country navigation.

Computer software for glider pilots

There's a small range of computer software intended for glider pilots. The programs range from simple for uploading tracks waypoints to and from GPS devices to more powerful software like SeeYou.

SeeYou is a flight planning and analysis program. It allows you to plan tasks over terrain maps using a library of waypoints and upload this to a GPS or glide computer. After the landing, you can download your flight track and analyse it.

Flights can be reflown on the computer so you can analyse your thermalling performance and decision making. If you've been flying a comp or in a group, flights can be reflown in sync.

You can see the statistics for your flight including the time spent circling, time spent in cruise, L/D etc. Some hand held GPS units can run programs like SeeYou for use in the glider. SeeYou is commonly used in competitions for planning tasks and coordinating scores.

Software is not just for experts though. When you're learning, tools like SeeYou can be very useful to analyse flights and thermalling performance to improve your cross-country skills.

Flarm and ADS-B

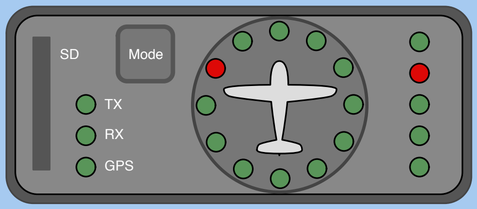
Two computer/GPS based instruments are available to increase situational awareness in gliders, Flarm and ADS-B.

Flarm is an instrument invented in Switzerland in 2003 to give glider pilots an audio-visual alert of other Flarm equipped aircraft and predict potential collisions.

Most Flarms have an integrated data logger which can be used to record flight tracks for badge claims, competitions and flight analysis. The Flarm also includes a world-wide terrain database which can be used to predict potential collisions with ground features from antennae to mountains.

ADS-B is a more recent technology which is used by a much wider range of general aviation, sport and transport aircraft. It's available as receive only (ADS-B in) and receive and transmit (ADS-B out). Full ADS-B installations can be expensive and use a lot of power.

ADS-B in is being increasingly fitted to gliders to provide optimal situation awareness of the traffic around you. Instruments such as PowerFlarm have both improved FLARM and ADS-B capability.



Flarm - Basic display

A basic Flarm display is a simple array of bright multi-coloured LEDs which indicate the direction of a potential threat, it's position in relationship to your aircraft and the height, either clear above or below, just above or below or at the same level.

Flarms are mandatory in most competitions and in many day to day club operations and it's likely that ADS-B will follow the same route.

Both technologies fix the speed and position of the aircraft the device is installed in using a built-in GPS and solid-state altimeter. The instrument's computer predicts the aircraft's future track and broadcasts this signal. The instrument also receives signals from other equipped aircraft within a range of 3 km or more and uses this information to predict potential collisions.

These devices can be connected to voice modules and also display weather information, the rate of climb and call sign of other aircraft giving pilots a more descriptive warning of potential hazards.

Flarm units use little power and are reasonably priced. ADS-B is somewhat more expensive and uses more power.

Since Flarm devices are mostly fitted only to gliders, it's a great technology for glider-only airspace where that exists. ADS-B can be fitted to a much wider range of aircraft and it has a much greater potential for making airspace safer. ADS-B is mandatory in Australia for aircraft flying under IFR (Instrument Flight Rules) but is not mandatory for VFR (Visual Flight Rules) which represents the majority of general aviation and sports flying. In fact the uptake of ADS-B in VFR powered aircraft is very low indeed.

If these technologies are going to have any real benefit, *all* aircraft including drones have to be fitted with collision avoidance technology. This will be a problem for gliders, particularly older gliders with limited ability to carry solar cells or heavy batteries but the likelihood is that ADS-B will at some time be mandatory for all aircraft.

Radio

Almost all gliders in Australia are fitted with a radio even though a radio is not mandatory. Radio is however, very useful.

The essential thing to remember about the use of a radio is the old adage, "aviate, navigate, communicate." What that means, especially to low hours pilots, is that their highest priority is to fly the aircraft and keep a good lookout for others.

The second priority is to make sure you're in full control of the glider and heading for the right place.

The biggest use of radio is when returning to the strip and circuit area to tell other aircraft where you are.

Make sure the radio is on the right frequency and that your glider is in the right place in the circuit before making radio calls. Your message should be clear and concise but it's essential that it's understandable. You don't need to rush. Transmission does not mean communication!

Incidentally, CASA recommends that radio calls are made just before you make a turn rather than afterwards. For example if you transmit "Glider Alpha Bravo Charlie turning base" other aircraft can look for the flash of light on the wings of a banking glider in the likely places. If you make a call after the turn, you're less likely to be visible to others.

Power supply in gliders

There's no doubt that technology such as GPS has revolutionised many aspects of gliding and most of it is good. However, getting these devices to work in a sunlit cockpit requires a lot of energy from batteries or solar panels.

With all glide computers there is a problem of power supply. The more powerful the computer and the bigger the display, the greater the power drain, especially where a system is fitted like a transponder or a device such as ADS-B which broadcasts and receives the position of civil aviation aircraft.

What happens when the electricity runs out? You might not lose all your instruments but things like radios which need a lot of power to transmit will stop working properly and you may not know that you are not transmitting as the battery voltage sags.

One of the best ways of providing more power to run these extra instruments is solar panels built into the glider's fuselage. This may be only possible with new gliders, but a couple of small solar panels can mean your battery voltage rarely drops, even during the longest flights.

Newer battery technology can be used to provide more power but the extent to which this is possible is limited by a few factors including whether the battery is available in a size which will fit a glider, whether a particular battery technology is certified to be used in a glider and whether the battery or its charging system are fire-proof enough that you would want to carry them in a glider cockpit.

Operating Procedures

Safety on the strip

Like any new activity, there are a few things to watch out for when you're starting gliding to make sure that you don't hurt yourself or damage the gliders. It's all part of airmanship.

We should always be on the lookout for other aircraft, gliders or tow planes on the strip or about to land and should never cross a strip in a car or on foot without scanning the sky to look for aircraft.

Tugs are not difficult to hear but most gliders are very quiet, even with air brakes extended and in an emergency or a wind change, gliders may land in any direction.

When a glider is taken to the launch point it may be "gridded" or placed in a queue with other gliders. When towing out, be careful to allow room for aircraft landing, tugs returning and other traffic on the strip.

If there's an active winch launch operation, be especially careful to look out for the winch cable on the ground or in the air and if you are not actively involved, keep well behind the launch point when gliders are being winched.

Ground handling gliders.

Like any aircraft, gliders are expensive and while gliders are as strong as they need to be, they're also built as light as possible. We have to take care not to damage gliders when moving gliders in and out of hangars, getting them to the launch point and parking them on the airstrip.

At most gliding clubs you'll be helping to get aircraft out of hangars on your first or second day and it might seem that there are hundreds of rules to learn about ground handling gliders… but it's not really the case. There's just a few rules and they're fairly easy to learn. The best rule of thumb to avoid damaging gliders on the ground is "keep a good look out and take things slowly!"

Most training gliders are pretty rugged and you can learn good practices without too much risk, but if you are asked to help with a glider you are not familiar with, take it easy.

One of the easiest places to damage a glider is in its own hangar, so never rush when getting a glider out of a hangar, a trailer or when moving it around the strip and always ask for a hand if you can't see what's happening all around the glider or can't manage a job alone.

In many clubs, gliders are packed tightly together with wings and tailplanes close together and near to the hangar structure so there's a specific packing order which has to be done just right. If that's the case, make sure you find someone to help you who knows the drill and take things slowly.

One big, fragile thing to watch out for is the glider's canopy. Canopies are very expensive, fragile and scratch and crack quite easily… and a scratched canopy can be difficult to see through and therefore dangerous. We look after our canopies!

Never leave the canopy open or unlocked when you are not right near the cockpit. Always close and lock the canopy when you move away from the glider for any reason, especially in a wind. Never lift a canopy by the clear view panel. Lift it by the frame or locking handle.

You may have seen painted signs on transport aircraft saying "No Step". It's the same with sailplanes, but we don't usually paint signs on their lovely finish! Always make sure that when you pull or push a glider, you never put your hands on the relatively fragile parts… the moving control surfaces, the canopy, on the thin trailing edges of wings and the tailplane.

When you're moving gliders around the strip, only one person should hold a wingtip. If you have one person on each tip, they may pull against each other and damage the glider. If the wind is very strong, make sure it's the upwind wingtip that you hold onto. If you have to swap to the nose or fuselage, make sure someone else holds the wing before you let go.

When gliders are moved to the launch point or back to the hangar, it's normal to hitch a rope to a vehicle and tow them. The range of vehicles used for this is fantastic… everything from cars with cut-off roofs to old tractors. In all cases the glider should never be towed faster than a moderate walking pace, so beware when using cars which have an automatic gearbox. Choose the smoothest path to the launch point and always keep a good lookout for obstacles near the wing tips.

Some gliders are towed nose first with the tow rope attached to the cable release and others are towed tail first either with a rope or a rigid bar off the tail dolly. Tail dollies make manoeuvring on the ground a lot easier, but it's essential to make sure the tail dolly is removed before flight. The dolly should always be removed when you park the glider to make it more difficult for the wind to rotate it.

You can fit an auxiliary wheel on a special fitting slid over the wing called a "wing walker" so a glider can be towed single handed with the wing walker on the wing and a tail dolly on the tail. However when doing circuits when training, the wing walker is often too slow to find and fit every time, so the wing is normally stabilised by hand… probably yours.

The golden rule when towing any glider with a rope is to make sure that the tow rope is longer than two thirds of a wing span. This way, if the glider should decide to turn by itself or overtake the car on a downhill slope, for example, the person on the wing tip can hold back to swing the glider clear and there's no chance of the a wing tip hitting the tow vehicle.

If a glider is being towed from the tail with a mechanical wing-walker attached to a wing and that wing lifts, stop immediately. It's possible that the ailerons on the low wing will hit the ground or a thick clump of grass and get damaged. Damage to control surfaces done when ground handling is one of the important items you will check in your walk-around before getting in the glider.

If a glider is towed with a strong wind from behind, the control surfaces can flap up and down and can get damaged. When towing in a wind, control surfaces should be stabilised by tightening the seat-harness over the joystick and chocking the rudder.

The rule when parking gliders outside during the day is to make sure the wings can't develop lift. That means in effect, don't park it nose into the wind, and make sure the air brakes are out to spoil the airflow over the wings.

Remember that in many gliders, pulling on full air brakes will also apply the wheel brake. This is a good idea when the glider is parked but remember to put away the air brakes before trying to move the glider.

When it's windy, gliders are normally parked tail into the wind at a slight diagonal with a tyre on the into-wind wing. If the strip has tie down wires, these can be used to secure gliders.

There may be ropes attached to the tie down wire which you can use. It's easy to loop a rope over the tail boom of a glider, but securing the wings takes more thought. You can't loop a rope over ailerons or flaps without putting something like a seat cushion on top of the wing, and passing the rope over the cushion to avoid damaging the control surfaces.

Alternatively, the cushion is put on the wing and two stakes or screw-its can be driven into the ground, one either side of the wing and a rope stretched between the two stakes. Before you go cross country, make sure the glider has a set of this tie-down equipment stowed somewhere secure.

Launch Methods

Winch launching

Around the world, winches used to launch gliders have developed from home made winches made from truck or car rear axles through war surplus balloon winches to powerful commercially built machines with multiple drums.

When fitted with a retrieve winch at the launch point, a modern single drum winch is capable of a launch every 4 minutes . Most winches are powered by a large petrol or diesel engine fitted to a heavy chassis which is well braced to take the load when launching a glider.

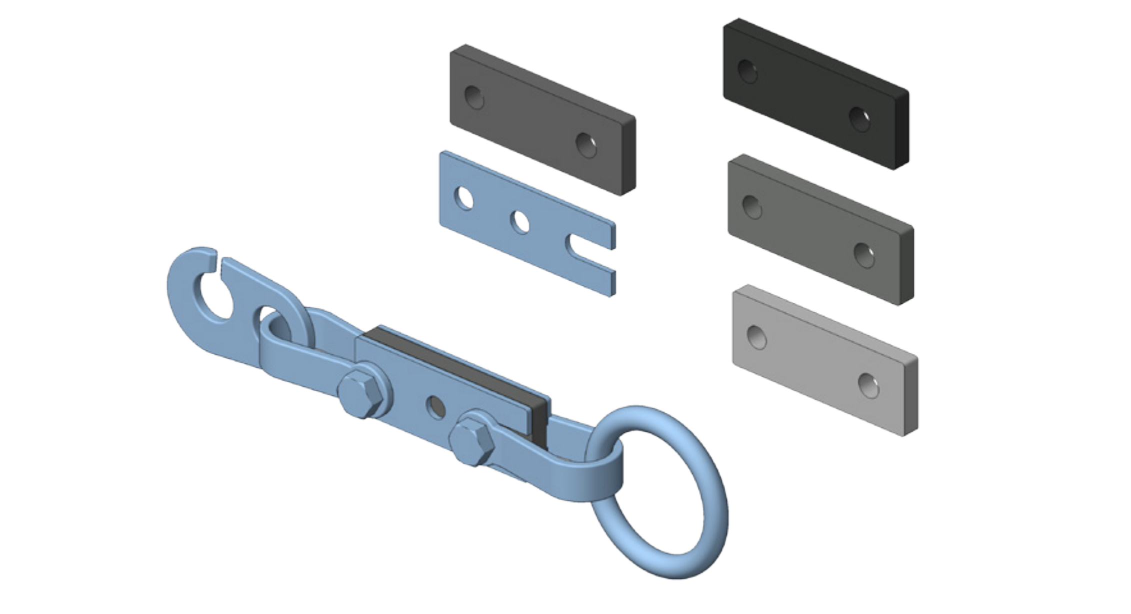
Winches vary a lot in power with some able to winch a heavy glider twice as high as less powerful winches. Because of this, the winch operator needs to know the type of glider being launched and have a list of suitable power settings for the winch, and a reliable method of communication with the launch point.

The winch engine drives a large drum through a gearbox and the winch cable is wound onto the drum by a mechanism to ensure an even wind.

Although traditionally known as cable, there's a range of material used for cable in different clubs depending on custom and the local environment. A common material is "Range 2 spring steel wire" of about 3mm diameter. Occasionally stranded wire rope of 4mm or 5mm diameter may be used instead of spring steel.

Synthetic rope made of polypropylene or polyethylene of about 8mm diameter is another suitable material which is relatively cheap and can be spliced if it breaks. Dyneema is a more modern and much higher strength synthetic rope which is smaller in diameter and lighter than commercial poly rope and allows higher tows because of its lower drag.

If the strip is dry and abrasive, stranded or braided ropes may wear excessively in use and not be economical compared with wire.



A weak link is always fitted between the glider and drogue parachute on a winch cable to protect the airframe from being overstressed by the winch.

When aerotowing, a weak link is normally fitted to both ends of the tow rope, glider and tug ends to protect both aircraft.

If only one weak link is fitted to an aerotow rope, it's normally fitted at the tug end to prevent damage and accidents in the event that the tow rope gets snagged on a fence or tree when the tug is landing.

The weak element in the link is normally sandwiched between protective plates. The slotted end faces towards the glider.

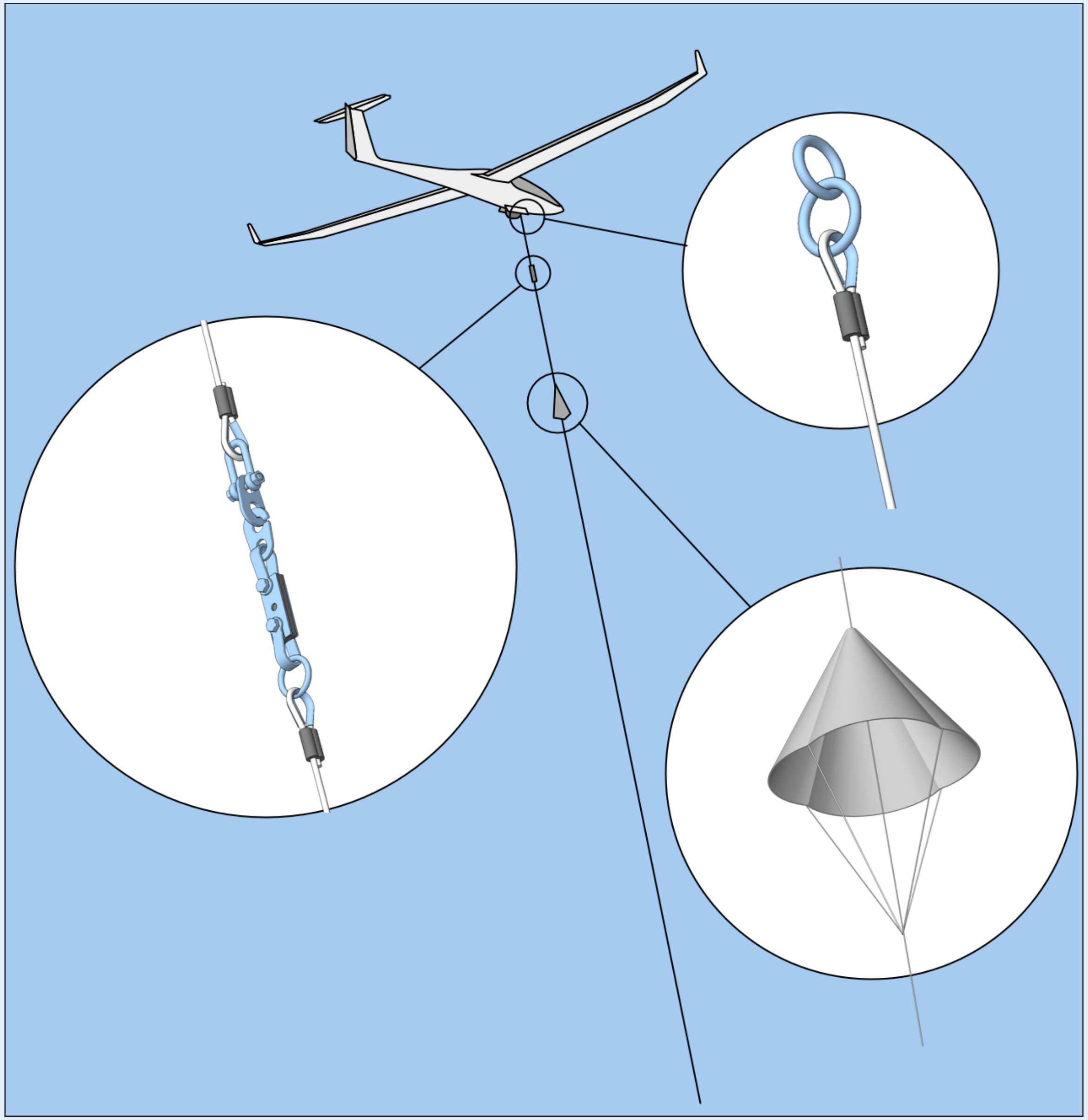
Weak links are available in a range of breaking strengths (or weaknesses) to suit different glider types and coloured for easy identification. The correct weak link to use can be found in a glider's flight manual and in GFA publications.

The tugs' weak link is normally set by the tug's flight manual and not changed when towing light or heavy gliders.

Winch cable fittings

At the end of the length of winch cable there are fittings which are important for safe launches.

- Swivel. This is used for taking out any cable twist caused by the drogue. It is optional for spring wire, but essential for wire rope.
- 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 rope instead of wire cables do not use a drogue.
- Weak link. This vital piece of equipment is fitted to protect the structure of the glider from damage due to too much power on the launch or the pilot trying to climb too steeply. The correct weak link for a particular glider must be used and you can find the specifications in each glider's flight manual and on cockpit placards.
- Trace. This serves as a spacer to keep the drogue at a suitable distance from the glider. The minimum length for a trace is 5 metres.
- Release rings. This is a linked pair of rings of standard "Tost" design. The smaller ring is inserted into the winch-release hook of gliders. Two rings are used so the force on the glider's tow-release is a straight pull irrespective of the angle on the cable.



A pair of linked release rings, often called Tost rings after the principal manufacturer, attaches the winch cable to the glider's belly release hook.

The release rings are connected by a rope or cable of at least 5 metres length to a quick release which is shackled to the weak link.

The slot in the weak link points towards the glider.

Below the weak link, there is another rope or cable of at least 10 metres in length. To this is normally fitted a drogue parachute. The drogue should be at least 15 metres from the glider while it is under tow.

The drogue parachute is rigged to remain closed while the winch cable is under tension.

When the cable is released, the drogue opens and slows the descent of the cable, making it more controllable and easier to retrieve. Where rope is used for the winch cable in place of wire, a drogue is not normally fitted.

The launch cable isn't connected to the glider until the last moment. Most gliders have two tow cable release mechanisms… a nose release for aerotowing and a belly or CofG release for winch launching. When the pilot is ready, they signal to the launch crew and pull on the cable release handle which opens both releases. The ring is placed in the glider's belly hook when winch launching. When the launch crew have got the ring in place, they signal to the pilot to close the hook.

Release mechanisms are always checked before the first flight of the day to make sure they will release under load. The crew will pull firmly on the launch cable and the pilot pulls on the release handle until the release hook lets go of the cable.

Belly releases are also required to have an automatic over-ride or back-release mechanism. This protects the glider if the cable fails to release when the pilot pulls the handle. The release senses the downward force on the hook and opens a back-release cage when an angle of over 75° is reached.

The back release is also checked before the first flight of each day, by pulling vertically down under tension. Checking a back-release by pulling the cable back towards the tail of the

glider is not enough. Where vertical pulls are not possible try to get the pull as vertical as you can.

Winches are equipped with a guillotine to cut the cable if it fails 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.

There's an important habit to get into when flying (in fact it's important everywhere when operating machinery).

You need to make absolutely sure that the control you are about to operate is the right one. The sequence is Locate, Identify, Operate. The controls in gliders are made or painted in standard colours and in many cases, different shapes to prevent mistakes.

Some controls such as the undercarriage, can be on the left or the right side of the glider. With some undercarriage controls, you pull back to raise the undercarriage and with others, you pull back to lower the undercarriage. It's essential to get into the habit of Locate, Identify, Operate to avoid mistakes with controls.

When launching, there's a lot going on in a short time and there will be a temptation to feel for controls without looking, but this is a bad idea.

The control which operates the foot pedal adjustment may be the same as the cable release and giving it a good pull may just move the rudder pedals.

Two very important secondary controls during the launch phase, both of which are always operated with your left hand, are the air brakes and the cable release.

If the air brakes are not closed and locked before launch, they can be sucked open as the airspeed increases. Then drag goes up to the point that a safe launch is in jeopardy.

Even though fully closed air brakes are checked during pre-launch checks, many pilots position their left arm or part of a hand so they'll feel any movement of the airbrakes during the initial stages of the launch.

The other critical control is the cable release. This may need to be operated very quickly if there's a launch emergency. So your hand should always be on the cable release during a winch launch.

The essential habit to learn is to look for the control you want to operate. Identify that it's the right one, and then and only then, operate it.

Car towing

For car towing (that is, launching with a car as the tow vehicle), apart from the winch, equipment and procedures are the same as for winch-launching. 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.

Aerotowing

When aerotowing, the tow rope is commonly made from a slightly stretchy, shock absorbing material such as nylon and is about 60 metres long. The weak link is fitted at the tow plane end to protect the tow plane if the rope gets hooked on a tree or fence when landing. Each end of the rope has a pair of double rings called Tost rings.

Where a glider is fitted with a nose and belly tow release, the nose release is always used for aerotowing. When towing with a release close to the nose, the pull on the tow rope gives the glider some extra directional stability making the pilot's work a little easier.

Some very light weight gliders need a weak link significantly weaker than that used by most tugs. In this case an additional weak link of the right strength for the glider will need to be fitted at the glider's end.

At the launch point

Before every takeoff, you do some checks. Almost every country has its own checklists and many clubs use their own localised check list but in Australia, all checklists are based on the GFA standard checklist.

Most checklists have a helpful mnemonic which you should memorise. Many training gliders have the mnemonic written somewhere visible in the cockpit while most self launchers use a more extensive printed checklist.

The first few essential checks which need doing before every takeoff are done by the pilot walking around the glider. This Walk-around is a ritual practiced in some way by all pilots, from ultralights right up to fast jets.

The Walk-around is to make sure that nothing has been overlooked during the daily inspection which normally happens when the glider is in the hangar or has just been rigged.

It's done to make sure that no damage has been done when the glider was brought to the launch point or in the previous landing. It's also to make sure that items like the tail dolly are not still attached to the fuselage and that nobody has tied their dog to the tail while they helped someone.

- Does the aircraft look right? Are things square and aligned properly?
- Are the wings firmly attached and at the right angle to the fuselage?
- Is there enough air in the tyres?
- Does ballast need to be installed in the glider for your weight?
- Has the tail dolly been removed?
- Do the control surfaces appear to be undamaged. Control surfaces can be damaged landing, towing out, mishandling and by strong winds.
- Are the controls working in the correct sense? If you are flying an older glider without automatic hookups, it is worth checking this even thought it may have been checked a few minutes earlier during the daily inspection.
- Are the right number of cushions in the glider? And not too many? When winching, cushions should not be soft and deep in case the pilot slides backwards with the acceleration and cannot operate the controls.
- If Oxygen may be required, is it turned on and are the masks easy to reach? In many gliders, this is not possible in flight and the oxygen should be readied before you get into the glider.

Pre-Boarding Checks

ABCD

A AIRFRAME	The walk around check for damage and defects. Maintenance release checked, including DI validity.
B BALLAST	Glider loading is within placarded limitations and trim ballast, if required, is secure.
C CONTROLS	Check the controls, including airbrakes and flaps, for correct sense and full deflections.
D DOLLIES	All dollies and ground handling equipment removed.

Pre-Takeoff Checks

CHAOTIC

C CONTROL ACCESS	Seat adjustments are secure and positioned to allow for comfortable access to all flight controls, switches & knobs and the tow release. Rudder pedals positions are adjusted.
H HARNESS	Secure the harness, lap-belt low on hips, for all pilots.
A AIRBRAKES & FLAPS	Watch as airbrakes are cycled and set for launch, or closed and locked. Where they're fitted, flaps set as required for takeoff.
O OUTSIDE	Airspace and take-off path are clear. Wind velocity and direction checked. Enough competent ground crew are available.
O OPTIONS	Note the glider's critical speeds for the launch method and safe speed near the ground. Have emergency plans in case of launch failure.
T TRIM	Correct ballast is confirmed. Trim set as required.
I INSTRUMENTS	Altimeter is set, other instruments are reading normally with no apparent damage. Radio is turned on, volume up and set to the correct frequency.
C CANOPY	Closed and locked.
C CARRIAGE	Undercarriage is locked down.
C CONTROLS	Checked for full and free movement.
C CABLE	Hook on.

Now and not before, the tow rope may be hooked on using the small ring.

When you've climbed into the glider, there are another set of checks. Cockpit checks are important and if you're interrupted, you'll want to begin again.

- Put on your harness and check that it is secure and that you cannot hit the canopy with your head or lean forwards too far. Check that any passengers have their harness secured.
- Operate the airbrakes. Can you open them fully, easily and symmetrically and close them firmly? Make sure they are closed for launching. Make sure your drinking water is not in the way of your arm or elbow when operating the airbrakes.
- If flaps are fitted, make sure they operate correctly and are set to takeoff position. With some flapped gliders, the flaps are set to negative for the initial takeoff run and only set to positive when there is enough wind speed over the control surfaces to have control authority.
- If the glider has a retractable undercarriage, locate and identify the placard which shows the sense in which the undercarriage lever operates. Don't touch the lever but make sure you know where it is and can read the placard. It's remarkable how many pilots fly with the wheel down and then smartly retract it just before landing.

• Check that the instruments are working and in good order and that the radio is on and tuned to the correct frequency. If necessary, make a short call on the radio to ask for a check on strength and clarity.

• Altimeter set to the strip's elevation above sea level.

• If the vario is beeping loudly, turn it down. It can be a distraction during a long aerotow.

• Set the trimmer to the correct setting for the type of launch you are doing.

• Note and remember the critical speeds for the launch method you're using today and after release, the safe speed near the ground in the current conditions.

Consider the options in the event of a takeoff emergency. Where are you going to go? Normally, there are three distinct scenarios.

• What to do if there is a low altitude emergency where normally the best option is to land straight ahead.

• What to do in a mid-height emergency. This is the critical one because it depends on a lot of factors which are discussed later under launch emergencies. Make a plan and remember it.

• For emergencies above the mid-height band, you'll have time to return to the strip but you need to consider where the mid height band is on this day with this wind and in this glider.

Finally, close the canopy, check the undercarriage is locked in the down position, check for full and free movement of the controls…that the stick and rudder can be moved to the end stops without obstruction. When these checks are completed, the cable can be hooked on and you're set for takeoff.

Most of these checks can be run through quickly once you get to know them but make sure you are thinking about each one, especially the essentials… Are the controls really working in the correct sense? Did you remove the tail dolly before getting into the glider? And most importantly, have you planned for all emergencies?

Launching signals

When a glider is ready to launch, there must be clear commands between the pilot, via the ground crew, to the operator of the winch, car or aircraft to begin the launch.

The responsibility is shared between the ground crew, which ideally includes a forward signaller for maximum safety, a wing runner and the pilot. Initially, the wing runner has to check that…

- The glider's canopy is closed and locked.
- The airbrakes are closed and locked.
- That the strip is clear and that airspace is clear to launch.

Because the pilot can only see ahead, it's one of the launch crew who checks if there is any traffic and it's the crew who permits or delays the launch. This is the final safety check before launching and is never omitted. The glider's wing is not lifted until the "Airspace clear to launch" signal is given.

The tug often moves onto the strip when the canopy is closed and waits for the wing to be lifted and the signal to take up slack. Lowering of a wing always means the launch is on hold or aborted.

If a pilot is unhappy in any way, or if a launch is unreasonably delayed, the glider pilot should pull the release and unhook the tow cable from the glider. It doesn't take long to hook it up again.

There are three launch stages. The stages and commands are the same whichever launch method is in use. The commands to initiate these stages are; Take-up slack, Full power or All Out and Stop!

Take up slack; the tow rope is slowly taken up by the tug, car or winch operator until there's no slack in the cable.

Full power or **All Out**; The tug, car or winch operator applies full (or appropriate) power to start the launch.

Stop! Stop! Stop! This signal is the most important of all and should be clearly understood by everyone near a glider being launched.

When the Stop command is given, the person supporting or running the wing must immediately lower it to the ground and hold both hands above their head.

The lowered wing alerts the pilot who may not be otherwise aware anything is wrong and it's normally seen by the tug pilot as well.

When the pilot is aware of the wing being lowered and sees the crew with their hands in the air, the pilot should immediately release the cable.

Nobody should ever be afraid of shouting Stop if it looks like something is not right. No-one will mind if there was no problem. The launch can easily be restarted and it is far more important that nobody gets hurt.

There may be any number of reasons for stopping a launch.

- The pilot has forgotten to lock the air brakes or canopy.
- Someone might be walking onto the strip
- Another glider might have to land early.
- The glider may have rolled over the tow rope, risking getting the undercarriage caught.

If there's any doubt, the launch must be stopped immediately. Anyone at the launch point can give a stop signal if they think something dangerous is about to happen.

Clear Communication.

A Method of communicating clearly between glider and launch system is essential. When aerotowing, the glider and tug are relatively close together compared with winching and communication is easy compared with winch or car towing.

Few airstrips are perfectly flat and some are not even straight so a range of methods has evolved for communication which run from semaphore-like arm signals to flashing lights.

Each has its own advantages and disadvantages. Arm signals should be clear and unmistakable, but if there's more than one signaller and one of them is looking the wrong way…

Radio is an obvious choice when launching, but not all gliders have a radio and not all radios work well enough for various reasons. Air band VHF radio is line-of-site and if there's a slope on the strip, people on the ground at each end of the strip may be unable to hear each other.

UHF CB radios are much better in this regard, but there are more non-flying users such as farmers and truckies, especially in the country, and some may object to or even interfere with launch chatter.

When aerotowing, the glider, tug and ground crew are closer to each other than with winch or car towing, but the two pilots may still not be able to see each other. Since the crew at the wingtip may be invisible in a tug's rear view mirror, there's usually a second ground crew standing somewhere that can be easily seen from the tug cockpit to relay signals.

Signalling lights can be used but in the heat of summer, the shimmering haze can easily distort a steady shining light into a flicker. The normal system is that a light with long flashes and short spaces means "take up slack", short flashes and short spaces mean "all out or full power". "Stop!" is a steady light. Variations on this system are used in hot, arid areas.

Where airstrips are large, ground crew can wave hats or fluro painted bats or paddles to make their movements more visible. The signals are exactly the same as for aerotowing. An underarm wave of the bat is Take up Slack, an overarm wave is All Out. The Stop signal is holding the bat steady over the head. The bat is large enough to be seen at a distance of well over a kilometre.

As a back up, in case of failure of any of these signalling systems, wing waggling may be used. Take up Slack is signalled by rocking the wings as far as the wingtip crew can manage. All Out is signalled by holding the wings steady and level. Stop is lowering the wing down to the ground.

Because of all these difficulties, gliding clubs have evolved their own local methods over time. In most cases, two methods may be used. For example the glider pilots radios Take up Slack to the tug while and wingtip crew signals with their arm. Of course if the glider pilot is unhappy, the release can be pulled at any time.

Aerotowing signals

All launch signals apart from Stop originate with the glider pilot. Normally they would be given as hand signals to the wing runner, but may be given by the pilot on the radio.

The wing runner should keep alert and aware of the changing situation at the launch point, looking for traffic in the pattern, gliders being towed out, airbrakes closed and locked and possible problems with things like the tow cable and if necessary, communicate these to the pilot.

In most cases, nothing will happen until the pilot has completed his cockpit checks and the canopy is seen to be closed and locked. Often, the tug will be watching and start moving in front of the glider as soon as the canopy closes.

Airspace clear for launch

Sitting in the cockpit, you can see what's going on in front and either side of the glider but you cannot see what's happening behind and you can't launch without checking for traffic.

With the help of someone outside, normally the wing runner, the aerodrome and sky are carefully scanned, especially for aircraft on finals. If the area is clear, the wing runner makes a clear signal to the pilot and says "Airspace clear for launch".

The wing runner does not lift the wing until this check is completed.

Pilot ready for takeoff

When you, the glider pilot have got the "airspace clear for launch" confirmation from the wing runner, you say "Pilot Ready For Take Off" and indicate with a clear thumbs up.

From the thumbs up signal, the wing runner manages the launch, though you can always pull the cable release to stop it.

The wing runner lifts the wing and waves their arm, perhaps holding their hat, in an underarm motion across their body.

If possible, the wing runner should make sure that they are standing in a position where the tug pilot can see these hand signals.

If your left hand is resting somewhere near the airbrake lever (to make sure it's closed) and in easy reach of the cable release, it doesn't hurt to keep your thumb up so the ground crew can see this confirmation throughout the take up slack procedure.

The wingtip crew's waving hand signal can be relayed to the tug pilot by another ground crew member acting as a forward signaller, standing in clear sight of the tug as it moves slowly forward to tighten the rope.

All Out or Full Power

When the slack is taken up, the wing runner gives the "All Out" or "Full Power" hand signal, moving their arm from waving below the waist to waving from side to side above their head. This will be relayed to the tug pilot by the forward signaller and the tug pilot applies power to start the takeoff.

Stop Stop Stop

If the launch needs to be stopped, the wingtip crew shouts "Stop, Stop Stop!" and lowers the wingtip to the ground and holds one or both arms above their head, fingers outstretched as a visual cue.

When you as the glider pilot hear "Stop", you immediately pull the release which unhooks the rope. The forward signaller repeats the stop command and raises both arms above his head. The tug pilot stops the takeoff.

Winch and car tow launching signals

The essential signals are the same as with aerotowing. The big difference between these two methods of launching and aerotowing is that the glider is a long way from the launch mechanism and on a sloping strip, the two may be out of sight from each other. This greatly increases the importance of reliable and accurate communication.

Launch piloting techniques

Winch Launching

When you are learning, you won't normally control the take off and landing phases of a flight until your instructor feels your awareness and coordination are right. The sounds and sensations of a launch can be a bit bewildering at first and appear to happen very quickly, especially at a busy site. With more experience, what at first may seem fast and uncontrollable becomes slower, ordered and routine.

Winch and car launching

From the pilot's point of view, these two launch methods are almost identical. The biggest difference is the speed at which things happen with winch launching. It's easy to talk about the individual stages of winch launching but until you experience a few, you don't realise how short each stage can be and how they tend to blend into one another.

There's a temptation when launching with these two methods to get greedy and pull the stick back and go into climb too soon and too fast to maximise the launch height beyond what's safe. It's absolutely essential to get into the habit of letting each stage of the launch take place for the right time and not rush anything.

Before launching

When winch launching, it's essential to make sure that the cushions in the glider are firm enough and that you are sitting in the right position to operate all the controls. If the cushions are too soft, there's a risk that with the initial acceleration of a winch launch, that you'll slide back and be unable to reach the controls.

Make sure your harness is done up tightly and position your left hand on the cable release so you can pull it in the shortest time.

Ground run and separation

Before giving the command to start the takeoff, it's essential to contact the winch by radio and let them know who is on the other end of the line and what glider is being launched and whether it is a single or two seater.

This is not so much of an issue with low power winches, but where the winch is powerful and can possibly over-speed the glider, letting the winch or car tow operator know what type of glider is on the end of the cable and who is the pilot in command will let them adjust the power and speed of the launch to suit the aircraft.

Most gliders, when trimmed fully forwards or nose down, will accelerate and rotate into the climb with little input from the pilot because the belly hook position is below the centre of gravity of the glider and when tension comes on the tow line it will tend to rotate the glider.

If the winch cable is taken up too rapidly or snatched in the early stage of a launch while the glider is still on the ground, you may not have enough elevator control to counteract the resulting rapid rotation and the tail wheel or skid may whack into the ground. The winch or car must be taken to full power gradually, without a snatch.

The precise control actions vary slightly from glider to glider, especially if they are nose wheel or tail wheel type gliders. Your instructor will give you the correct procedure for each type. In almost all cases in the early ground run, the trim and the stick will be right forwards to keep the nose from pitching upwards.

The time for the ground run and separation stage depends on the power of the tow mechanism, but it may be well under 10 seconds. Winching is fast and you need to be alert.

Because the belly hook used for these types of launching is close to the centre of gravity, and the airspeed is too low for the control surfaces to have much authority, the glider does not have much directional stability in the early stages of a launch. You must have your hand on the cable release ready for emergencies.

If you can't keep the wings level, release immediately. If a wing touches the ground when winch launching, the glider may ground loop.

This is very important on sites where there's longer grass, especially wet green grass which can cause a lot more drag than the normal dusty dry conditions of a typical bush airstrip.

The ground crew should be very careful not to let a launch start if the winch cable isn't straight. A strong tuft of grass may hold the winch cable at an angle to the glider instead of straight up and down the strip. Don't hope that the grass will let go of the cable and it will pull straight. The crew should call "Stop!" and you should release immediately.

Occasionally when aerotowing, gliders are launched without a wing runner, with one wing resting on the ground. This is never ever done when winch launching; a wing runner is always used to minimise the risk of a wing touching the ground.

Initial climb

When the glider is airborne, hold it level until the airspeed has increased to 1.3 times VS before progressively easing the stick back into a climb. The absolute minimum speed for rotating into climb is 1.3 times the stall speed. Because everything happens so fast when winch launching, it's better to err on the side of safety and let the speed get a little high rather than too low.

If the airspeed slows below 1.3 x Vs, immediately pull the cable release twice and land straight ahead.

Maximum winch launch speed

The manufacturer of each glider gives a maximum winch launch speed in the glider's flight manual and it's always printed on a cockpit placard. Sometimes this maximum winch launch speed seems remarkably close to 1.3 times the stall speed. You may think this narrow speed range is very small considering the breathtaking rate of acceleration you can get with winch launching.

However the loads on the glider are very low in this early launch stage and the placarded maximum winch launch speed may be safely exceeded near the ground. Never exceed the placarded maximum winch launch speed once in full climb, especially near the top of the climb.

If the speed is above 1.3 Vs and the glider is accelerating well, you can allow it to be rotated into the climb at a moderate speed. In most gliders, the rotation to climb will happen more or less automatically, even with a nose down trim because of the attitude of the glider and the belly release position of the winch cable.

You need to control the rate of rotation to make sure it does not happen too fast. At least five seconds should elapse between horizontal flight and when the glider is established in the climb. Since the stall speed of an aircraft is related to G loading, pulling a glider steeply into a climb straight off launch is a sure way to enter an unrecoverable stall-spin.

Use moderate control inputs to make sure that the glider smoothly transitions into a full climb.

Full climb

A typical full climb is remarkably steep, about 40-45 degrees nose up and you'll have no view of the ground over the nose. However, your peripheral vision is enough to let you keep the glider heading in the right direction. Unless there's a strong crosswind, keep the view of the ground either side of the nose the same.

Airspeed and climb angle should be constantly checked by a glance at the ASI and the angle of the horizon over the wing. Don't let the speed get too low or too high.

If there is a crosswind, the glider will need to be banked so that it tracks down the windward side of the strip. This way, when you release the winch cable, it will fall on the strip and be easy to recover.

From inside the glider, the amount of aileron and rudder you have to use to achieve this seems enormous, but from the ground it doesn't appear so great.

Winch launching can be as exciting as any fairground ride but there's not much work for the pilot to do once the glider is established in climb. As the pilot, your main job is to use the stick and elevator to keep the speed in the working speed band between 1.3 times the stall speed and the glider's maximum winch launch speed.

In the early stage of the climb you need to watch that the glider is flying fast enough and always be ready to firmly push the nose down to gain speed, especially if there is any feeling of the winch or car losing power and if the speed doesn't return when the glider's in level flight, pull the release and land normally.

The main danger of exceeding the maximum winch launch speed is over-stressing the wings at the top of the climb, as the glider levels out and the winch cable loads are taken almost vertically.

If the climb speed is too high in the first few hundred feet of the climb when the glider is close to the ground, let the glider climb gently as possible to a safe height.

Signal to the winch driver by yawing the glider with deliberate rudder movements with opposite aileron to prevent the glider banking. The snaking motion of the glider should look deliberate rather than a display of sloppy flying.

If you cannot signal or the winch driver does not reduce power, release and land normally.

Winch launch cable release

As the glider reaches the top of the climb, the pull of the cable angles more downwards and the nose lowers to the point where the glider is flying almost horizontally and you can see the horizon.

After a few flights, you'll work the right release point by some ground reference but you will probably not see the winch below.

At this stage the winch cable is close to vertical and since no more height can be gained, the operator or car driver will reduce power.

You can feel this in the cockpit and as the glider slows, push the stick forwards to lower the nose below the horizon to a normal flying attitude. Now is the time to release.

Pull the release firmly twice to make sure the cable is unhooked. It's very important to make sure that the glider is flying at a safe speed before making a turn and starting looking for lift.

It may take some seconds, especially in a training glider, for the glider to accelerate to the correct speed so get the attitude of the glider right and do your post-release checks.

If the aircraft has flaps, set them to the recommended position for normal flight and raise the undercarriage. Check the ASI and trim the aircraft before making any turn.

Aerotow launching

Aerotowing is a quite different process to winching or car towing. For a start, things happen more slowly. It can take five minutes and more to gain height before you release and an aerotow costs a lot more than a winch launch. The big advantage of aerotowing is that you can feel the air on the way up for thermals and the tuggie will try to take you to where other gliders are circling or to the house thermal so you can usually release right into one.

Aerotowing is an exercise in formation flying and you have to control the aircraft more than you would when winching. The rope attached to the nose-hook of the glider is quite short… about 55 metres. Your job is to maintain a steady formation behind the tug.

At first when you're training and flying in smooth conditions, this formation flying may not be too difficult, but if the conditions are good and thermic, both the tug and glider on tow may be rising and falling, bobbing up and down as they climb. Additionally, if there's crosswind on the strip creating turbulence, it can make the low part of the flight more fun.

Fun? Well yes. When you get used to aerotowing and you can handle rougher conditions, aerotowing in rowdy air can definitely be fun. But possibly more work than winch launching.

Low tow and high tow

In Australia we tow in what is called the low tow position. This is where the glider sits just below the tug's slipstream and prop-wash.
In most other countries they tow in high tow where the glider sits just above the tug's slip stream. Why this difference?

The answer is tug upsets. In high tow, there is a significant risk that if the glider gets too high above the tug, the glider can kite upwards and tip the tug into a stall and dive. If the combination of tug and glider are close to the ground, the tug may not be able to recover. This is called a tug upset.

Tug upsets

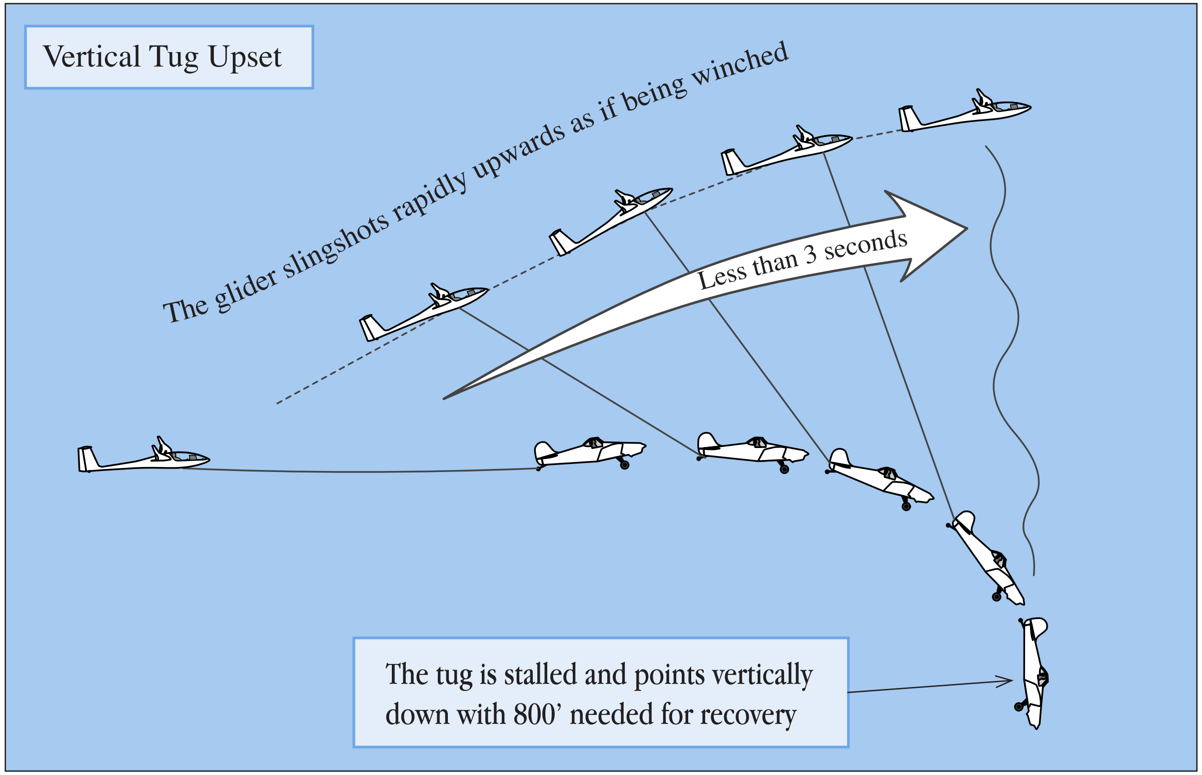
A tug upset happens when the glider on tow gets far enough out of position that the tug pilot no longer has control over the tug. Tug upsets are largely caused by the glider pilot and can be fatal for the tug pilot, so it's essential to understand how they occur and what to do if an upset looks likely.

In a tug upset, the glider on tow gets too high, pulling the tail of the tug upwards. This type of tug upset may happen very rapidly…in perhaps 2-3 seconds. The glider zooms rapidly upwards at a high angle of climb, more like winching than aerotowing. A vertical tug upset can even happen before the tug is airborne if the glider climbs too rapidly.

The tug rapidly slows and pitches nose down in a deep stall. At this point either the weak link breaks or one of the aircraft releases. If the upset happens at low altitude the tug may not have enough height to recover, even from as high as 800' and the result is often fatal.

It's important to realise how quickly this type of upset can happen and if the tug disappears from your view, you must release immediately.

When aerotowing, always make sure that you are paying complete attention to the position of the glider in relation to the tug when on tow and if you cannot maintain position, release.



There are several factors which increase the chance of getting into a situation where a tug upset is likely to happen.

- Aerotowing using a belly or CofG tow hook.
- The glider has high-mounted wings.
- The glider is lightweight or has a low wing loading as with some training and older gliders.
- The glider pilot has low hours on aerotow.
- Lightweight pilots where an aft C of G makes the glider more pitch sensitive.
- Short tow ropes.
- Gusty or very thermic conditions.

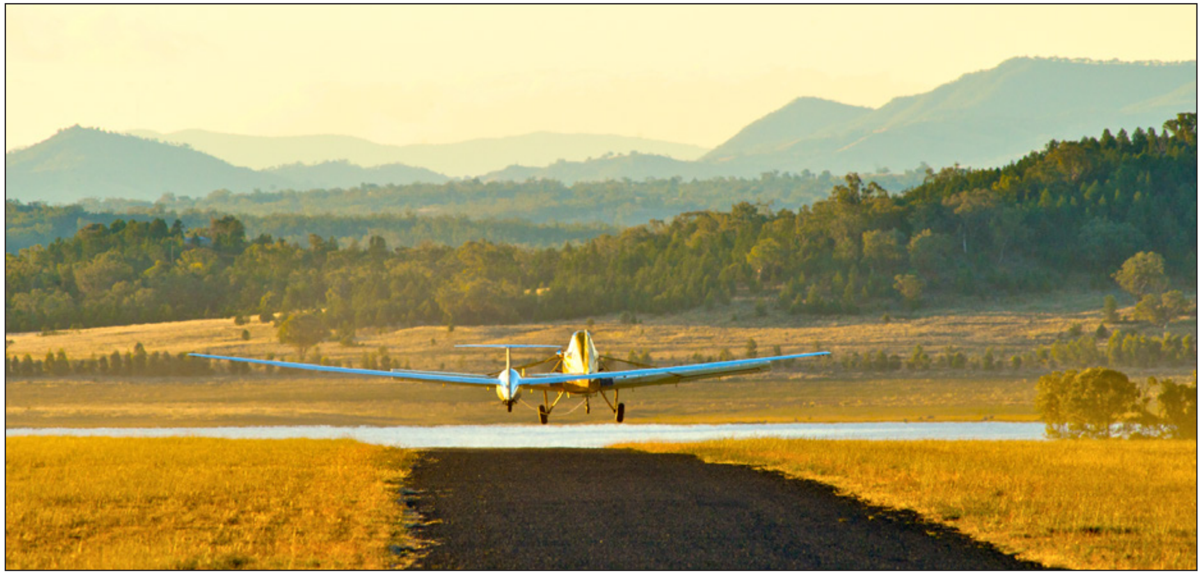
Obviously, a combination of these factors, such as a lightweight glider, with a lightweight low-hours pilot on a short tow rope increases the odds of an upset.

In Australia, the low tow position is used because it's considered that this type of tug upset accident is highly unlikely when the glider is in the low position and low tow better suits our thermic conditions. But that does not mean tug upsets cannot happen.

If a tug upset looks likely, either the glider or the tug should release.

That being said, if you plan to fly overseas, it is worth learning how to high tow but make sure that everyone, especially the tuggie, has been briefed that you want to practice a high tow.

If you are practicing high tows, be sure to move into the high tow position at a moderate speed, keeping the tow rope taut until you're just above the slipstream. In that position, take a reference between the tug and the horizon and maintain that position during the tow. If you cannot see the tug for any reason, release immediately.



Pre-takeoff and ground run

Before you start the launch, it's a good idea to contact the tug and let them know who is on tow… what type of glider and who is the pilot in charge. There are several reasons for this. First, the tug pilot can make sure the speed is right for the glider type and conditions and secondly, the tug pilot will try to give low airtime pilots a more relaxed ride.

This is not to say that experienced pilots get a rough ride, but if the tug pilot finds a thermal, it's not uncommon for the tug to bank tightly into the thermal and use what lift there is to improve the rate of climb. This is not a problem to experienced pilots but the tight turns may be difficult for low airtime pilots.

On tow, the glider is normally going to be flying quite fast… 55 to 65 knots. To reduce the control forces on the stick, the trim lever is normally set forwards of neutral so if you're distracted, the glider will tend to speed up.

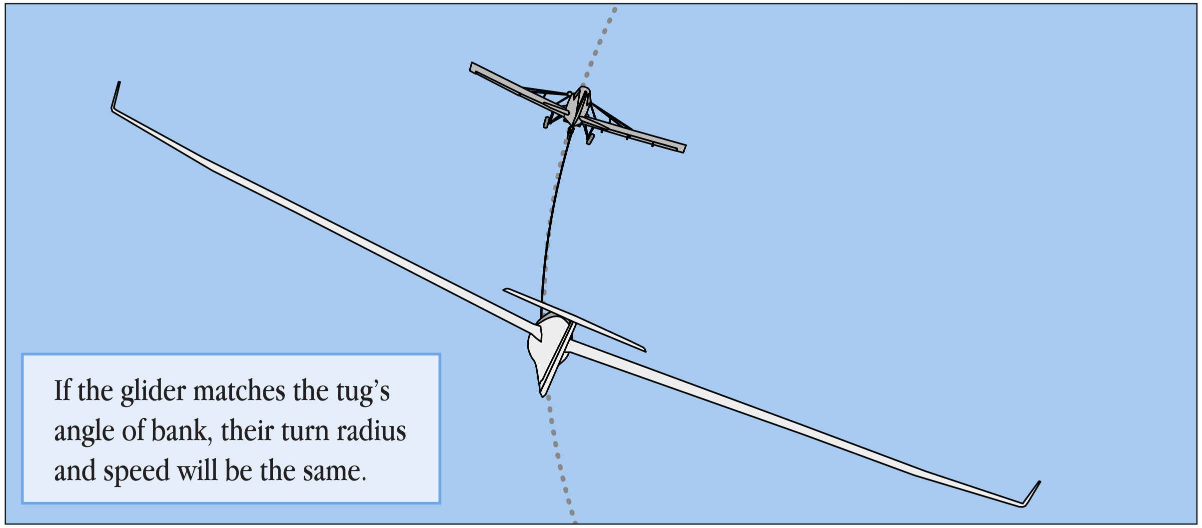
You can re-trim if necessary when airborne so that the glider keeps station behind the tug without you having to use much fore and aft pressure on the stick, but in most cases the trim should be forwards when aerotowing.

Because a tug accelerates the glider more slowly than a winch, it takes longer to get control authority so you will normally use large stick movements early in the roll to maintain the right takeoff attitude, reducing as the glider gathers speed.

When the tail wheel lifts, the glider may also weathercock or yaw as it rolls along the ground. You correct this using the rudder pedals. Because of the low airspeed in the early part of the ground run, large rudder movements may be needed to get the glider pointing behind the tug.

When the glider is airborne, the stick and the rudder are moved in a coordinated fashion. In crosswind takeoffs, these movements may need to be independent… perhaps left foot forwards to correct a swing to the right and stick hard over to the right to correct a left wing down.

Not many of us are natural fliers, so don't worry if you don't get the hang of moving the rudder and stick independently on the ground right away. Your instructor will always take over if things get out of hand and telling-offs are rare for this misdemeanour!



If the glider matches the tug's angle of bank, their turn radius and speed will be the same.

Separation and climb-away

The glider will lift off before the tug and you should let it climb until it's about 3 metres or just above the tug's fin. There's a temptation to skim close above the ground but this can be dangerous in turbulence and a moderate amount of height at this early stage in the flight gives you a good safety margin and you can relax and wait until the tug lifts off.

Don't let the glider climb too fast or too high above normal high tow position or you may prevent the tug getting airborne. As the tug starts to climb, allow the glider to climb until you're out of any turbulent zone near trees or buildings.

Then lower the nose and descend into the low tow position. While the glider is in the tug's slipstream you will have a little more work to until you are at in the low tow.

As soon as the buffeting fades away, you'll be close to the low tow position and the nose of the glider can be raised by easing the stick back so that the glider flies in station just below the slipstream.

This position will vary slightly from tug to tug. It is easy to check at any time… just let the glider climb a little and as soon as the buffeting begins, lower the nose to bring the glider down out of the slipstream.

Now, pick a point on the tug where the tailplane appears to cut across something like a rear view mirror, wing or strut.

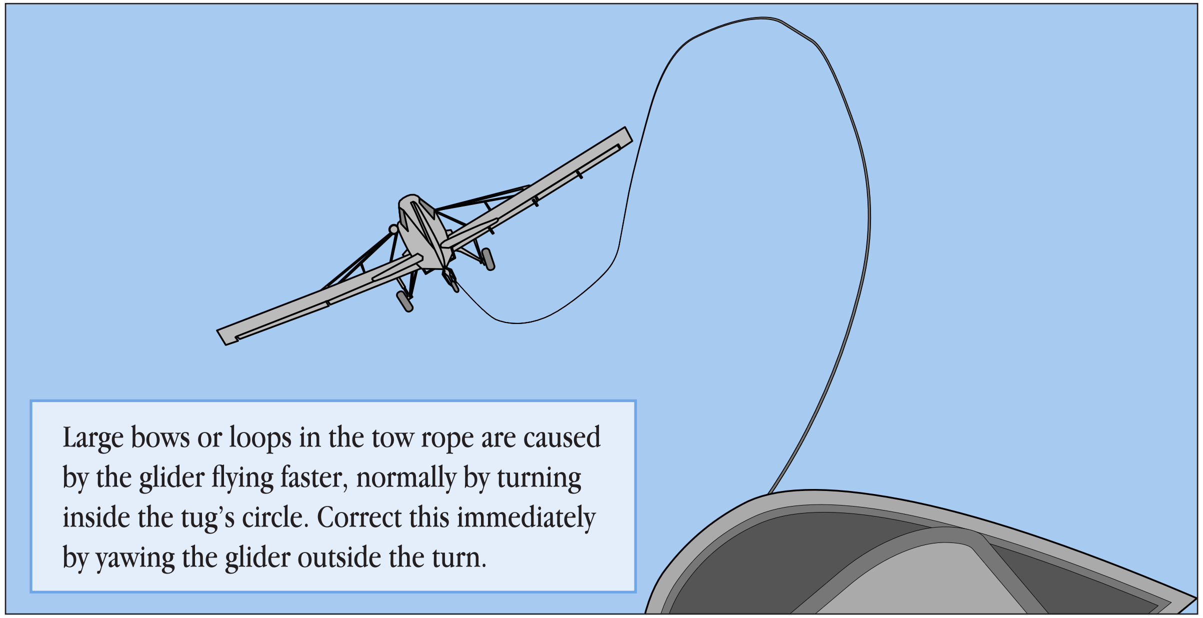
This is the visual reference for the correct point for your formation flying. As the combination climbs, you've got to try and maintain this position and a visual cue is easier than testing by being buffeted by the slipstream.

Normal climb

The tug and glider should maintain this formation throughout the climb. If the stick forces are too high, use the trim lever to get the stick neutral.

Your control movements should be small and early rather than late and large. It's easy to say this but when you are learning, it will take some time to recognise that the glider is out of station. If the air is smooth, you should not have much difficulty maintaining position behind the tug when climbing.

The essential thing is keep the rope taut and stay in station behind the tug. When the tug turns, match your angle of bank to the tug's angle of bank. Properly done, matching the tug's angle of bank will make sure that the two aircraft stay in formation.



Large bows or loops in the tow rope are caused by the glider flying faster, normally by turning inside the tug's circle. Correct this immediately by yawing the glider outside the turn.

When the air is more active, both aircraft will rise and fall as they fly through sink and lift and you'll have to do a bit more work, especially when turning.

The tow rope should be in a straight line between the glider and tug. If it is at an angle to the glider's nose, you are out of position.

Use a little rudder to point the glider's nose at the tail of the tug in a turn to stop you turning wider than the tug. Matching the glider's bank angle to that of the tug will help keep the glider in position.

If the tow rope is allowed to get slack enough that a large loop or bow is formed, there's a risk the loop may fall back over the glider's wing. You need to immediately slow the glider down in relationship to the tug. There are several ways to achieve this.

If you apply rudder to yaw the glider out of the turn, the glider's drag will increase, slowing it down and straightening the rope. You may have to bank slightly into the turn to stay with the tug. The result should be that the glider moves outwards and slows.

This action should be performed promptly and you should be ready to bring back the glider in line with the tug as soon as the loop has gone.

If the loop in the tow rope is small, popping the airbrakes a small amount early on can fix the problem but if the loop is large enough to get close to the glider's wing, the airbrakes should never be opened in case the rope catches on the airbrake.

Release

At the top of the tow it's time to release. When is the top of the tow? Hopefully, this is when you are in a thermal. Sometimes the tow will be up to a set height, perhaps 2,000' above ground and the tug may level off at this height, waiting for the glider to release.

When you are early solo, you may want to take a tow a little higher than normal to give yourself time to sort yourself out and find some lift. Just clear this with the tuggie before you launch.

When you are more experienced, some tuggies crank the tug around in a fairly steep turn to get the most from a thermal, so things can be quite busy at release time though when you're in the early stages of training, the air will probably be nice and smooth.

After release, in Australia the glider turns to the right and the tug will mostly fly in a diving turn to the left but do not bet on this, especially when overseas. In other countries, the glider may turn to the left or in any direction it wants, so if you are flying overseas, check this first!

The glider pilot must also check to the left and below as well as to the right to make completely sure that the airspace is clear for both aircraft to manoeuvre.

In any case, before you make any turn, you must check to make absolutely sure that nobody is flying in the direction of your turn and it's essential to get into this habit when releasing off tow.

Before releasing have a good look around, to check that the airspace is clear, locate and identify the release handle… it's the yellow one… double check that the airspace is clear, make sure that the tow rope is reasonably tight and then give the release handle a firm pull, all the way out, until the glider releases.

Before turning, make sure that the glider is released… watch the tow rope snake away from the front of the glider before banking. If you bank energetically before releasing it's likely to cause a rope break or even a tug upset.

If the glider is reasonably slippery and a light load on the tow plane, the tug may not know that the glider has released. It's a good idea in this case to make a short radio call such as "Alpha bravo charlie released" to let the tuggie know they can get back to the strip.

Post-release & pre-landing check list

FUST

F	**FLAPS**	Set as placarded. Ensure they are not in negative setting.
U	**UNDERCARRIAGE**	Post-launching: Undercarriage raised as placarded.. Pre-landing: Undercarriage down and locked as placarded.
S	**SPEED**	Set to a safe speed. Below 1000' set to Safe speed near the ground.
T	**TRIM**	Set for the selected speed in the circuit. Disposable ballast drained.

After every release and after joining the downwind leg before landing you should make a few configuration checks. FUST is a simple mnemonic to remind us what to check.

Flaps. Launch: If you're flying a flapped glider, set the flaps to the position which suits your current speed. If you are already in a thermal, choose a thermal setting, but if you are searching for lift, choose a slow cruise flap setting. Before landing set the flaps for the circuit and landing.

Undercarriage. Post-launch, fully raise the undercarriage. Pre-landing, lower and lock the undercarriage. Always look at the undercarriage lever when operating it, especially when landing. It's not uncommon for pilots to forget to raise their undercarriage in the post-release check and then raise the gear just before landing. Remember, Look, Identify, Operate.

Speed. After releasing, set your speed to suit the conditions. If you are looking for a thermal, set an appropriate cruise speed to give you better control. If you are already in a thermal, set a speed suitable for thermalling.

When landing, set a final approach speed of not less than the 1.5 times stall speed plus half the wind speed. You can do this as soon as you break off from soaring but make sure the glider is properly trimmed by the time the glider is alongside your intended landing point on the downwind leg and continue to check this as you fly the rest of the circuit.

Trim. Set the trim lever so the glider maintains the desired speed without much fore and aft force on the stick.

You should know with only the shortest glance where all the controls are. A quick glance at to locate and identify the essential controls such as the trim lever should be all you need.

Before landing, make sure you have dumped any water ballast. Modern gliders can carry hundreds of litres of water which may take several minutes to drain.

You may want to turn down the volume on the vario. Some pilots turn the vario all the way down during takeoff and landing.

It's especially important to have a good lookout regime when you're close to a strip, so don't spend too long with your eyes inside the cockpit but regularly glance at the ASI, especially on final approach to check your speed.

Handling different launch conditions.

A sailor can sail a boat, but a seaman is at home on the sea. A pilot can steer an aircraft but an airman is as much at home in the air as any human can aspire to be… we should all aspire to be airmen! Handling all sorts of different weather is just one aspect of it.

Gliding is a very weather related sport and over time, good airmen and women become sensitive to all sorts of weather cues which will give hints as to the day's flying conditions. These cues may be as simple as watching the wind in the tree tops or the way it crosses grassy fields on your way to the strip, or watching first clouds form and noting the time of day, their shape and height.

The cues can be something as obscure and mythical as the way the wooden table tops warp in the pub up at Burketown giving a clue as to wether the humidity is right for a Morning Glory roll cloud to appear the following morning.

Ideally when you go gliding, you launch into a slight headwind which is running straight down the strip, climb out at a good rate, release and hook into a smooth 10 knot thermal which takes you up to top of climb. Normally of course, this doesn't happen.

For a start, the wind is unlikely to be straight down the strip and sooner or later you will need to know how to take off and land in a moderate cross wind.

There are two schools of thought about how to learn to cope with things like cross winds and both have their merits. Some people find that mentally rehearsing every possibility helps before meeting the real thing.

There's no doubt that this works; you see top aerobatic pilots rehearsing their routines on the ground with their arms spread like school kids pretending to be fighter pilots.

Others find that learning how to fly the aircraft in a more general way will enable them to forget the specifics of cross winds and control the aircraft so they get the glider into the attitude they want, almost regardless of the conditions.

During the takeoff roll, a cross wind will affect the glider in two ways. The pressure of the wind on the tail will tend to turn the plane into the wind… this is called weather-cocking.

The wind will also try and lift the windward or into-wind wing and press the down-wind wing into the ground. Rudder and aileron will be needed on takeoff to keep the glider pointed at the tug and the wings level and it is certainly a good idea to anticipate the control inputs you'll need to get the glider to go where you want.

Bear in mind that you'll need larger and faster control movements early in the roll when there's less wind over the control surfaces.

Cross wind launching

At first, cross wind takeoffs and landings are likely to focus your attention nicely, but in any case you should estimate the cross wind component well before launching and recheck it before you close the canopy.

To properly fly cross wind takeoffs and landings, you may need to move the rudder in the opposite sense to the way you have learned when doing coordinated turns in flight. This is called "crossed controls" and can be difficult to master at first.

If the wind is coming over the port wing, the glider will tend to weathercock to the left and you'll need to use right rudder to keep the glider in a straight line and probably a touch of left aileron to keep the wings level.

Don't worry if you can't get the hang of it right away… most of us get it mostly right fairly soon to the point where foot movements in crosswind takeoffs and landings are unconscious.

With winch or car tow launching the initial acceleration is rapid and you will have control over the aircraft quite early, but you should anticipate the weather-cocking and be prepared to correct it with a measured boot-full of rudder.

Make sure the wings are level but be prepared to hold the into-wind wing low to prevent the wind lifting it, and most importantly, be prepared to pull the cable release if a wing looks like touching the ground.

When winch or car launching in a crosswind you want to fly the glider on the upwind side of the strip so after release, the cable drops down onto the strip and not into the trees.

Fly the glider with the into-wind wing held slightly low and the glider yawed into wind. This isn't a sideslip. The glider is flying into the crosswind, in balanced flight, towards the upwind side of the strip.

You won't be able to see anything over the nose to get an idea of downwind drift so you must look out sideways to gauge the position of the glider. From inside the cockpit, the amount of bank required can seem huge, but from the ground the attitude of the glider doesn't look nearly as odd.

When aerotow launching, the glider accelerates more slowly and it will take longer for you to have full control.

When the glider is running on its main wheel alone, the wind can more easily weathercock the glider, but by that stage you should have enough rudder control to correct this. Initial control movements are likely to be large.

As soon as the glider lifts off, if the wind is strong or particularly cross to the strip, the glider will tend to drift downwind unless corrected. The glider may swing out to the side of the strip as if in an overtaking move while the tug is still running on the strip, wheels on the ground. Because the mental picture is unfamiliar, it may be confusing at first but in fact the situation is normal for a crosswind takeoff.

Hold the into-wind wing low, keep the glider yawed towards the tug with the rudder and as soon as the tug lifts off, the glider can be brought back into line behind the tug and the two aircraft can take up their normal positions for the climb-out.

Landing

Not Flying, Landing.

At some point in all flights you must make the decision that you're no longer soaring, you are now landing. When do you make this decision?

What's important here is that the change from soaring to landing must be a conscious decision and once it's made, you must not change your mind.

Whether you are flying cross-country or have just released from launch, at 2000' AGL, even though you are searching for lift, you must *always* have a safe landing place selected. Not only that, you should know how you will enter and fly a circuit to land there. If left and right hand circuits are OK, there may be one or two points at which you can join a downwind leg.

At 1500' AGL you should have selected a circuit joining point and, while continuing to search for lift, you keep this well in sight. Having got the planning out of the way, you're a lot less stressed about looking for lift because you know where you have to be if you don't find any.

The point at which you break off from soaring and start landing depends on a few factors but with most gliders, it's going to be at a height from which you can safely reach the circuit joining area between 800' and 1000' AGL.

When local soaring, the break-off point may not seem such a big deal but when cross country soaring, it is. Failing to break off from soaring early enough and bungling an outlanding is a significant cause of accidents. Outlanding is stressful enough, so why make it worse by rushing the process of circuit planning?

You will feel a lot better opening the canopy on the ground and saying "There was lift all through the circuit, I bet I could have stayed up.' than climbing out of a broken glider saying something less quotable because you stuffed up the landing by rushing things.

The chances of landing at 2000' are not high but they probably double for every 350' that you lose and at 1000', the chances of a landing are very high indeed. On a big day, where thermals are 6 knots or more, they're going to be further apart and when you are low down, your chances of finding one will be less than on a more gentle day.

The immutable law of thermals says that if there's 6 knots up, there is going to be 6 knots going down somewhere. Murphy's law says that there will be a lot more than that. Most of us have flown on days where there were rivers of sink, vast expanses of unexplainable and inescapable sink all around. 1000' of sink is not uncommon. That means from normal circuit height, *you could be on the ground in a minute!*

There's going to be more turbulence lower down. Even if you do find a thermal, though your piloting skills may be good enough that you can fly safe, well coordinated turns in rowdy air, your airmanship skills should tell you not to take thermals low down, especially after breaking off from soaring.

It is essential to be disciplined about the break-off point. Mark it by configuring the glider for landing and doing your pre-landing checks. Don't go back on this decision to stop soaring.

Make your decision early about what height your break-off point is going to be… and don't diddle yourself, stick to this decision! Dump water ballast early so you don't arrive on finals full of water.

You lower the undercarriage in your pre-landing checks but if you decide to catch a thermal in the circuit and with a bit of luck, get away, the chances are high that you will forget the undercarriage is still lowered. Next time you do your pre-landing checks, you run the risk of raising the undercarriage, ready for a wheels-up landing. Play safe and respect your break-off decision.

Safe landings

The requirements for a safe landing will vary due to the conditions at the time. Wind, the angle of the sun, the slope of the strip and any other traffic in the area should be included in your planning.

You need to have:

- A Safe Speed Near The Ground. (SSNG)
- A Safe and Stable Approach.
- A Safe Final Turn onto Approach with a safe speed and ground clearance.

A Safe Speed Near the Ground = 1.5 times Stall Speed - SSNG = 1.5 Vs

A Safe and Stable Approach comes from a well-managed circuit and medium banked final turn onto Approach at the right time, with appropriate airspeed and altitude in a correctly configured glider.

A Safe Approach Speed = 1.5 times Stall Speed plus half wind gust speed = 1.5 Vs + 0.5 Vw

The Break Off decision is important to achieving a safe circuit and landing. Disregard lift after the Break Off Decision.

Configure the glider for landing early, when you transition from being a soaring pilot (or launching pilot) to a landing pilot.

Lower the undercarriage, dump water ballast, check and if necessary set the radio frequency, set flaps and SSNG and trim for that safe speed.

The pre-landing check is a check, not action list. Visually check that the flaps are set and the undercarriage is down and locked against the placard near the handle.

Confirm Trim for Safe Speed Near The Ground.

Continually monitor the angles to the landing area and turn in if the vertical angle is becoming too shallow or flat.

The faster the rate of flattening of the angle, the bolder the correction required. Assess and act immediately. Any correction will improve the angle.

A Safe Final Turn. Monitor and adjust SSNG, track and altitude to achieve safe angles, and a safe, well banked final turn onto Approach.

Aviate, navigate, communicate. Fly with safe attitude and a Safe Speed Near the Ground all the way into the flare.

Learning Landing

There's a saying that goes "A good landing is any one you walk away from" but we can do better than that! But learning landing can take some time for many of us.

Pulling off a good landing every time seems to be more difficult than making a good takeoff. You do a truly heroic landing one day, floating the glider down the strip in ground effect, lightly touching down and rolling to a stop exactly where you want to… And the next flight you bounce the glider down the strip in an imitation of a kangaroo trying to imitate a glider.

We almost all do this from time to time, often through getting into some bad habit later on in our gliding career. Remember, if you think you've lost your ability to land well, there are always instructors on hand who can help out.

A good landing starts with a good approach

Here's another truism… "A good landing starts with a good approach". The better your circuit and approach, the more likely it is that you will do a good landing.

The point of a standard circuit pattern is to position the glider in the best place to have a stabilised final approach. A stabilised approach is one where the glider is positioned in the right place, with the right airspeed and rate of descent.

An odd thing about many of us is that we can fly all day for hundreds of kilometres in a glider. Then when returning to the strip we suddenly get the idea in our heads that the glider is going to hit massive sink and suddenly fall out of the sky… and we plan our approach with that in mind, coming in with full brakes to wash off the excess height.

We often cramp our circuits by flying our downwind leg too close to the strip and that leads to a short base leg and a hurried final leg.

Cramped circuits and bad approaches lead to less than perfect landings whether you're landing at your home strip or making an outlanding.

If you get into the habit of making a good approach, you will get into the habit of making good landings.

Plan your circuit well and fly to that plan, and you will always be within easy reach of the strip, should conditions suddenly change. If you are flying at an unfamiliar site, always ask the locals how they fly circuits.

At airstrips near enough to the coast to be influenced by sea breezes, conditions can change rapidly later in the day. At airfields in the mountains, waterfalls of katabatic air can fall down the slopes into valleys and create big sink or lift. At mountain sites, the sink may be potentially so big that all final legs are set up with the intention of using full airbrakes. Local knowledge is very useful so pay attention to locals and ignore their opinion at your peril!

Visualise your final approach path

A good approach begins with visualisation… getting a mental picture of your flight path through the circuit and down onto the strip. If you've never flown before, getting this mental picture quickly and correctly can take some practice.

Not only, that, you may have to plan more than one approach. There may be gliders in the circuit or on the ground or as you approach the strip, you may see the wind on the ground is not as you thought. Whatever the reason, you'll often need to visualise more than one circuit plan.

Touring motor gliders are an excellent tool for learning circuit planning. It's possible to fly half a dozen circuits in a 30 minute flight, giving you plenty of time for practicing different approaches. If a motor glider flight isn't an option, you can mentally rehearse the shape of a final approach on the ground with any length of rope and a couple of sticks or people to hold it at the corners.

One end of the rope is put on the ground and marks where you intend to round out before landing. You hold the other end lined up with your initial approach path in the circuit joining area and two helpers hold the rope at the base and final turn points.

The rope marks the path of your landing circuit and should make it easy to see a few things. One is that the angle of your viewpoint from the cockpit to the point where you are intending to touch down, remains fairly constant throughout the circuit.

See how you can join the circuit at a different point on the slope and shorten or lengthen your approach path to suit the prevailing conditions by varying the length of each leg, but your eye-line angle remains more or less the same.

It's really important to give yourself time to think before you get close to landing so you can plan your circuit as well as any alternatives. As soon as you begin to think about landing, whether before you take off or when you return to the strip after a flight, you need to form a mental picture of the situation. This will include factors like your proposed landing area and direction, the surrounding terrain, wind direction, sun angle and traffic in the area.

Rather than give specific heights when rounding out, it's useful to talk about heights which we all know about. If we start rounding out at 'roof height', the range of roof heights nicely covers the general range of heights suitable for rounding out.

Table height is more specific. It's the height at which you should have finished rounding out before putting the glider at chair height.

When you're at chair height, you ease the stick back to 'hold the glider off' until it settles into a gentle landing.

Situational Awareness

These days this mental picture is called "Situational Awareness". Good situational awareness is essential when entering a circuit and circuits are designed to make this as easy as possible… that's another reason why we do them.

To begin with, your landings will probably be at the club strip where you are training and you won't need to spend so much time on assessing the landing area. This is covered in much greater detail in the Outlandings section later on in this manual.

You'll want to get into the habit of assessing wind, sun, traffic and other factors early so you can decide on your landing direction early and give yourself plenty of time to plan the circuit.

Normally, your landing direction will be into wind, but there are factors which can affect your decision. If the sun is low, you may want to avoid a base leg or finals looking directly into the sun.

If the strip has a slope, given the choice of landing downhill and into the wind or making a downwind landing uphill, the uphill option may be the better choice… it normally is.

On approaching the circuit joining area, your first task is to increase your lookout for other aircraft in or near the circuit. There may also be obstacles or wildlife on the ground and in the air around the strip.

The most likely obstacles you are going to face at most gliding clubs are tugs and gliders on the ground or other traffic in the area.

You should already have a good idea what the wind strength and direction is and know what is your preferred landing direction, but check the windsock to see if the wind has changed while you were airborne.

Have another look at the situation on the ground. There may be gliders who landed earlier and have not cleared from the strip. Has there been any radio traffic?

There may be gliders already on approach to the strip who have decided to land in the other direction to you and there may be launches in progress.

Are gliders still launching? Where's the tug? As you approach, you should be prepared to modify your plans based on the current situation on and in the air around the strip.

On many airfields, particularly those which are shared with powered aircraft, there may be a preferred circuit direction. At some strips all aircraft share the same strip and the same circuit direction and on others, glider traffic and powered traffic use opposite sides of the field and land on separate runways.

The GFA Operational Regulations state that "When in the circuit area of an aerodrome a sailplane shall when possible be flown such that all turns are made to the left, except at those aerodromes where turns to the right are required by CASA.

That being said, gliders more flexible about circuit patterns than powered aircraft and a circuit may be carried out in any direction if it is necessary. You may see a wide variation in landing approaches any day at a club, including straight in approaches, none of which is breaking any law.

It is essential that extra care is taken if you are going against the normal direction to minimise disruption to other airfield users. In a glider, taking legalities and conventions into account, it is better to fly a circuit in the wrong direction than risk getting too low trying to get to the conventional side of the circuit. This topic is covered in more detail at the end of this section.

Don't do a straight-in landing unless you must, and then take extra care looking for traffic etc. because your options are very limited compared with when flying a conventional circuit.

If there is a cross wind component and you can choose the circuit direction, the most sensible direction all other things being equal, is one where the base leg is into wind. A down-wind heading on a base leg will make your base leg shorter and can make the turn onto final more hurried than it should be, reducing the time for making decisions..

You should carry out your pre-landing checks soon early to leave yourself free to concentrate on the circuit and keeping a lookout. Use the radio to let other aircraft in the area and any ground operations on the strip know your intentions.

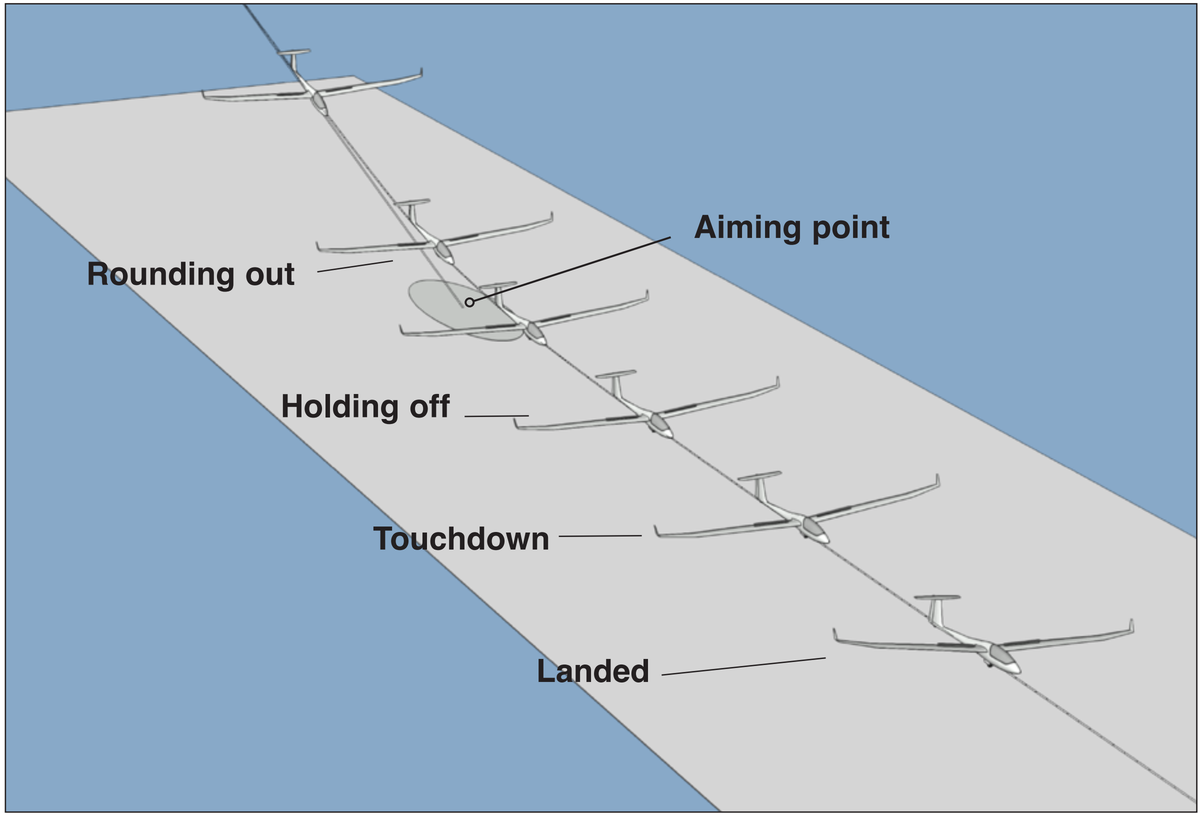
CASA advises that the best place to do this is *just before you enter the circuit joining area*. There are good reasons for this. Aircraft and especially gliders are hard to see at the best of times but they are easier to see when banking or turning. So if you give a radio call… "Alpha Bravo Charlie turning base" just before you make a turn in the circuit, other aircraft will have a better idea of where to look for you.

It is normal to do a call as you join a circuit and if things are busy in the area, it's a good idea to make another call when you turn onto base or final.

But remember, not all gliders have working radios and it's not uncommon for training aircraft or gliders which have been flying a long day to have run their batteries flat and transmissions may be distorted, weak or missing altogether. Don't rely on radio above keeping a constant lookout in the circuit.

As you fly your circuit, keep a sharp lookout for other aircraft. On each leg, look out not only for aircraft which are on the same circuit pattern as you, but also for aircraft which are flying the opposite hand circuit to land on the same strip as you and for any aircraft which may be doing a modified circuit or a straight-in landing.

The Aiming Point



About the time when you join the circuit, you work out your general landing area. This may dictated by a lot of things, including other gliders ahead of you in the circuit, the wind on the ground, the slope of the runway and any obstacles on the ground such as gliders, tugs and wildlife. It may be modified by obstacles on the approach path such as trees and whether the approach path is steep or shallow.

On a grass strip, you may have the choice of landing left, centre or right, while on a bitumen strip you may have only the bitumen in the centre, though you can still land short or long.

When you've got the landing area visualised, make a quick assessment of where you want to stop and how long the ground run is going to be. You may want to stop near the launch point, a hangar or a taxi-way but never choose convenience over safety.

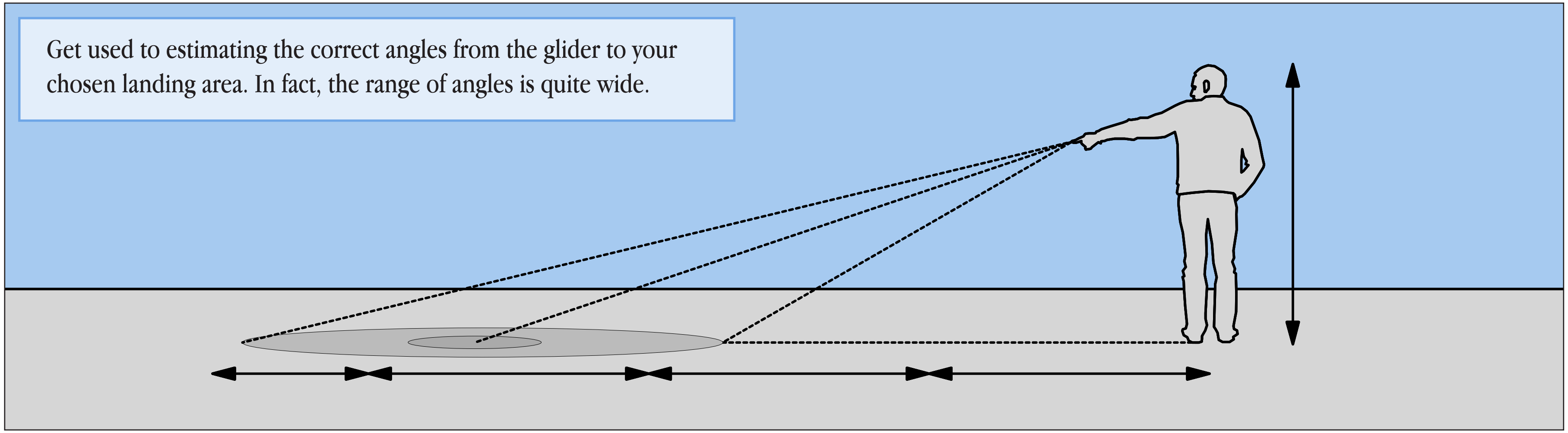
On bitumen, you may have a long smooth ground roll while on a bumpy grass strip you may get a much shorter run. If the glider's wheel brakes are effective, you will have more control over where the glider stops than if they're not.

Then you work back to where you think you're going to round out and make that your aiming point. The aiming point corresponds to where the rope touched the ground in the circuit visualisation exercise, the point where you'd whack in if you didn't round out.

You line up the aiming point against the canopy on finals so you can make sure you're overshooting before pulling airbrakes. You will begin to round out over the aiming point and touch down further along the strip.

The aiming point may be the beginning of a bitumen strip or it may be just a different coloured patch of grass.

The aiming point can even be parallel to the strip such as a structure or the pie cart but it is essential to select somewhere.



Get used to estimating the correct angles from the glider to your chosen landing area. In fact, the range of angles is quite wide.

Make sure that your aiming point is well clear of obstacles like trees, power lines and other aircraft on the strip and plan your approach path to be at least a wingspan above.

If possible, look for an undershoot area where you can land if you misjudge the approach due to unexpected sink or wind gradient on final approach.

If this is not an option and you'll be landing into a reasonably strong headwind, think about moving your aiming point further along the strip to increase your options.

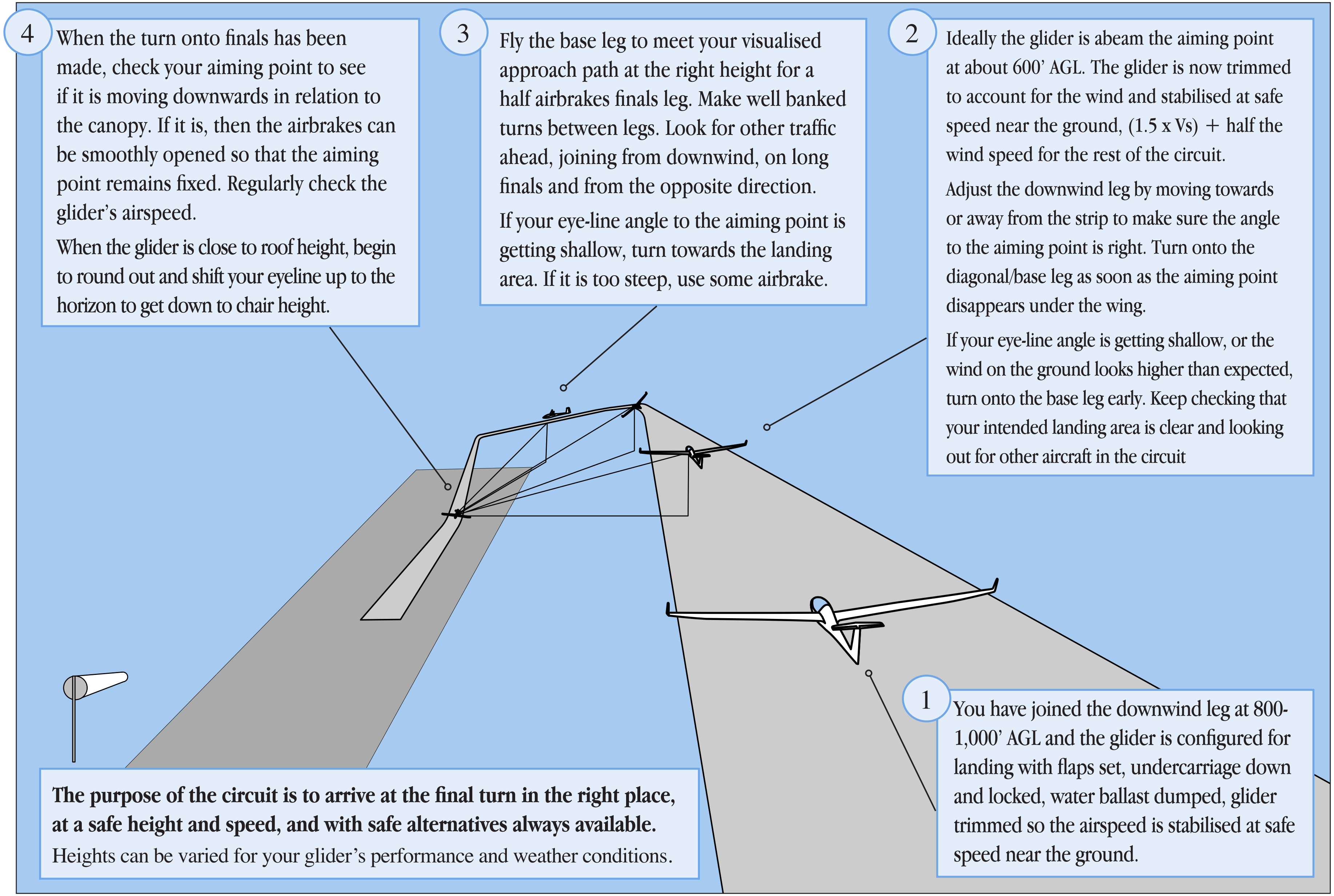
Bear in mind that you don't want to get too fixated about the aiming point. The situation on the ground can change rapidly due to all sorts of factors such as roos or an emus taking an afternoon stroll or other gliders landing ahead of you which might mean a change in plans.

To get an idea of the correct range of angles between you and your aiming point on the downwind leg, make a mark on the ground and walk six to seven metres away.

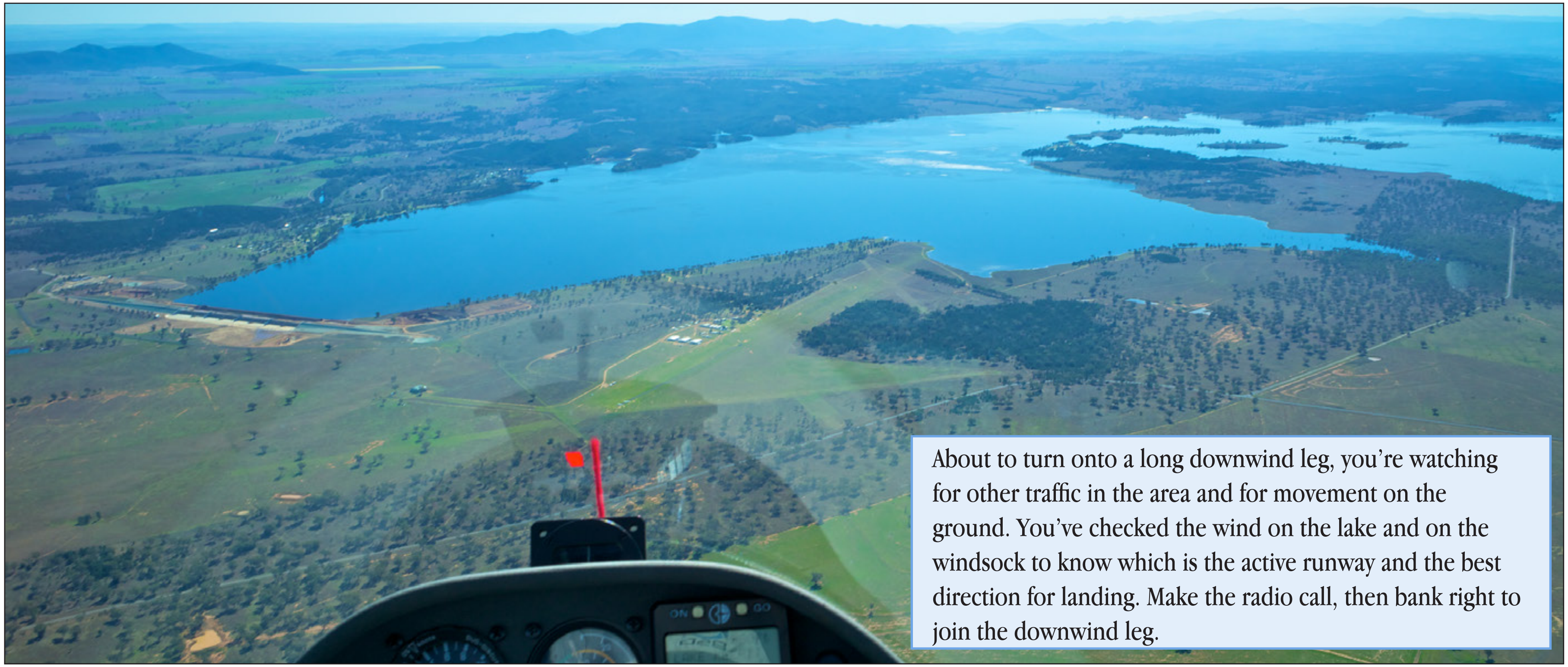
Stand with the mark to your side and your hand pointing at the mark. Sighting along your arm, your eyeline angle down to the mark on the ground is more or less the same as the aiming point should be in relationship to a glider entering the downwind leg under normal conditions of wind and sink.

If there's a lot of sink around or the wind is stronger, the angle can be steeper. If the glider is higher performance, there's little sink or even lift in the circuit and not much wind, then the angle can be shallower.

Flying the circuit



The Downwind leg.



About to turn onto a long downwind leg, you're watching for other traffic in the area and for movement on the ground. You've checked the wind on the lake and on the windsock to know which is the active runway and the best direction for landing. Make the radio call, then bank right to join the downwind leg.

In all your flying, the sequence of events should be: **Aviate, Navigate, Communicate**. Make sure your speed is never less than 1.5 x Vs. Allow enough time to make a radio call to let everyone know what you are doing just before you join the downwind leg so other traffic can watch out for you.

It's easier to spot a banking aircraft. If you are pushed for time, then just fly the glider.

The radio call should take the form: "Traffic Forbes, Glider Apha Charlie Bravo joining downwind onto 17. Forbes"

When your chosen landing area is coming up on the wingtip, re-trim the glider to approach speed allowing for the wind… (1.5 x Vs + ½ wind speed).

If there are obstructions such as trees or houses or a ridge over which you will fly on your final approach, there may be turbulence and sink. In a wind stronger than 10 knots, the turbulence and sink may be significant so don't run the risk of coming in too low and close.

If there's a strong headwind, your landing roll will be shorter than normal so make your aiming point further along the strip so you have enough height over the obstructions. Check the eye-line angle to your aiming point.

Regularly reassess your height above ground and angle to the landing area on the downwind leg. Is the angle too steep? If so, turn away for a few seconds, making sure that you look out for other aircraft before turning, so that the angle gets more shallow. If the angle is too shallow already, then bank towards the strip for a few seconds, before rolling back to a track parallel to the strip.

What about height? If you are a little too high extend the downwind leg, don't pull airbrakes.

If you are too low, consider cutting short the downwind leg and turning onto base earlier.

Watch the angle! More importantly, watch the rate of change of the angle. If you can see that the angle is flattening then you're in sink and need to turn in towards the strip until the angle stops flattening. The faster it's flattening, the larger your correction needs to be.

As you'd expect, there's another mnemonic… "If it flattens, a turn-in happens." Vice versa, if the angle is changing to a steeper one, turn out for a while. There is no mnemonic for that.

It's often easier to detect the rate of change of the angle rather than concentrating on the angle itself. If you find this difficult at first, practice in the car or on a bike, preferably in an empty car park where there's no one else in the circuit!

While you're flying on the downwind leg, take another look at the windsock and continually reassess the wind on the ground. You always need to add 50% of the wind speed to your safe speed above the ground and check your speed more frequently when in the circuit.

If the wind is strong, be aware that you will be going faster on your downwind leg than normal and that the downwind leg is going to take less time and things will happen more quickly. You need to get essentials out of the way early and be prepared to make your turn onto base sooner.

On windy days, consider a longer downwind leg to give yourself plenty of time in the circuit.

You should have set the trimmer to give the right airspeed before joining the downwind leg so stick loads will be light and you'll have less work to do. Fine tune the trim now if necessary.

As your aiming point passes abeam, you should be around 600' AGL. There's a great deal of variance in this altitude which depends on factors such as the glider's performance, the wind and weather, the terrain and the location of the strip.

In good conditions in a high performance glider, you might join downwind at 1,000' AGL and still have 700' when you turn onto finals. In a training or low performance glider, you'll lose height faster and have to be more careful.

If there's a lot of wind and sink around, it pays to fly the downwind and base legs higher and more conservatively. The same applies in the mountains or if the strip is higher than the surrounding terrain where it's harder to judge the height of the landing area

Practice assessing your height using features on the ground like trees and buildings rather than the altimeter. Be aware that up or down sloping strips can trick your brain into thinking the strip is higher or lower than it really is. These circuit illusions are quite common… there's a discussion about this later on.

Learn to fly your circuit by your eye-line angle to the aiming point you picked on the strip. Sooner or later you will outland or arrive at a destination where you won't be able to rely on your altimeter.

Don't get fixated on objects on the ground. If you find you are saying to yourself, "I always turn onto base when I'm over the dam (tree, road, hangar" or whatever else you can see) you are getting yourself into a very bad habit!

If you fly at a new strip, land in an unfamiliar direction or outland or if there's a strong wind, these familiar markers will mislead you. They are not your friends! The eye-line angle to your aiming point is the only true guide.

Turns in the circuit

When you make turns in the circuit, make them positive and well-banked. This takes some commitment at first because turns near the ground are always more… shall we say involving… than turns at altitude.

However, the fact is that you lose less height doing a well-banked turn than a shallow turn because the turn takes less time. Also there is less chance of stalling in a well-banked turn. Of course, make quite sure that the airspace around you is clear before you start any turn.

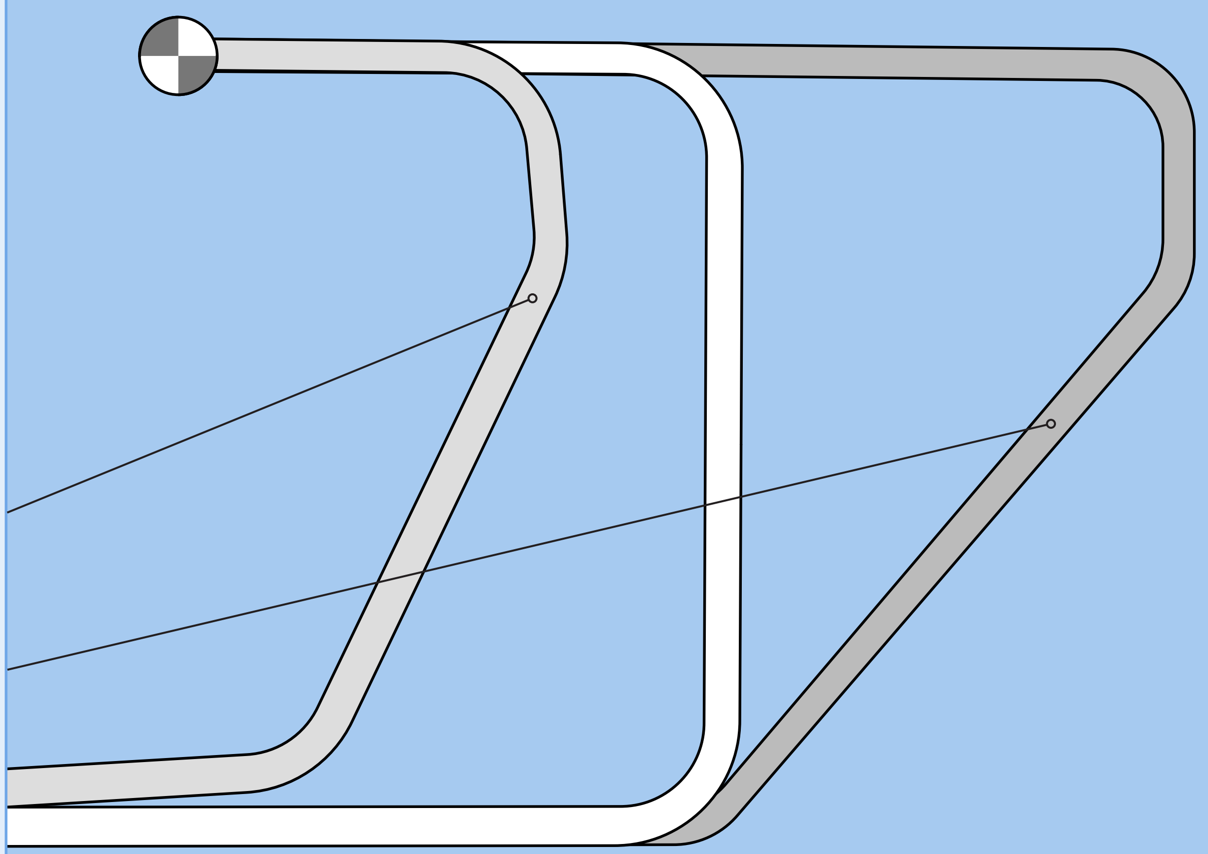
We fly a circuit to put the glider at the right height with the right descent rate on the final approach with the glider stabilised at Safe speed near the ground - 1.5 x Vs + half the wind speed. How you get there can be quite variable.

Be aware that on airstrips with mixed traffic, power aircraft will expect to see other aircraft in the normal place but cutting the corner or extending base with a diagonal leg is often a safe alternative to a standard square circuit.

If you get a lot of sink or there's a stronger headwind on the ground than anticipated, shorten the downwind leg, perhaps turning onto a diagonal leg to shorten the base leg.

If you are too high or get a lot of lift on the downwind leg, you can extend the downwind leg, keeping a good eye on your angle to the landing area and fly a longer final leg.

Don't make the mistake of flying a circuit via landmarks on the ground. And never fly a circuit low and slow!



Diagonal & base legs

There are two schools of thought about the base leg. Traditionally, gliders have flown the same circuit as powered aircraft but increasingly, gliders are flying a slightly different circuit where the base leg may be not be rigorously at 90º to the downwind and final legs and a partially diagonal section may be added.

If you are flying on a strip which is shared with powered aircraft, you will probably have to fly a standard aircraft circuit pattern of downwind, base and final legs and the GFA prefers this method. If you are able to modify the base leg and add a diagonal, you may find there are several advantages.

First, you never need to lose sight of the strip and your aiming point. With a conventional circuit, you may lose sight of your aiming point under the wing on the downwind leg which increases the chances of error and increases the pressure on you, the pilot.

Secondly, a diagonal leg allows you more freedom and control in flying the circuit. If you are unsure about conditions such as the wind, sink or your height above ground, you can turn early onto a diagonal leg and continually reassess how you are going, modifying your heading until you turn onto base proper.

If a diagonal leg is permitted or necessary, turn onto it when you lose sight of your aiming point… about when it passes under the wing.

On your diagonal and base legs, continue to scan in front of you for traffic in the approach pattern and obstacles on the ground.

Turning Base

The aim of the base and diagonal legs is that you turn the glider onto final approach at the right place and height above the ground. In most conditions, you don't want to turn onto final approach below 300', especially if it is windy or there are obstacles such as trees or buildings in the approach path.

Following your visualised approach path, you'll turn onto base about when your aiming point starts to disappear under the wing and when the eye-line angle to the landing area looks about right. This angle will be more or less the same throughout your circuit so the right time to turn onto base should not be hard to judge.

If you are a little too high, turn slightly away from the strip to stretch out the base leg and final approach. If you are getting low, turn onto base right away.

If you have time before you turn onto base, make a radio call. This is a good idea if other aircraft are in the circuit area. Remember, the rule is Aviate, Navigate, Communicate. Fly the plane first. Make sure you are completely confident about the first two before you worry about extra radio calls.

When you've turned onto base, locate and identify the airbrakes or spoiler handle and put your hand on it. From then on, keep your hand there unless it's essential to adjust the flaps or radio and then immediately return your hand to the airbrakes.

One reason for keeping your hand there is that on some gliders, it's fairly easy to confuse the airbrake and flap handles or even the airbrake and undercarriage handles and there have been a few accidents and near misses where the wrong control was operated.

If you confuse flaps with airbrakes you may apply negative flaps instead of closing the brakes. This will result in a loss of height as the glider accelerates to increase the lift… and this is not what you want, right near the ground.

On base, looking ahead, you can scan for traffic which may be doing an opposite hand circuit to you. Looking left and right, you can scan for traffic which is ahead of you in the circuit or which may be doing a straight-in landing.

Safe speed near the ground has to be maintained throughout the circuit and you cannot maintain that without looking at the ASI from time to time… but it only needs a quick glance. Always check your speed before turning onto finals and constantly after that… perhaps once every 4-5 seconds.

Continually reassess the glider's position in relationship to where you want to turn onto final approach and adjust the length and angle of the base and diagonal legs if you need to.

Airbrakes Before Finals

Don't open the airbrake lever before or during your turn onto finals. You want to check and make absolutely sure that you will overshoot your aiming point on the strip before throwing away height and energy with airbrakes.

Having airbrakes out in a turn can change the feel of the glider, increase the stall speed and affect the attitude so it's important to use airbrakes when you're flying more or less straight, such as when on final approach.

Make your turn onto final approach when the strip starts to line up. A 30^{o} bank at 55 knots will take about 150 metres, so don't leave the turn too late and make sure your turn is well banked and properly coordinated.

Repeatedly check your speed. Remember when you pull airbrakes, the stall speed will increase and the attitude of the glider may change.

After the turn check to see if you're lined up with the strip? If not, fix this with gentle S turns. Is your speed correct? If all this is OK, then line your aiming point up against some mark on the canopy.

If you have done everything more or less right, your aiming point will be moving downwards with respect to this mark and if you do nothing else, you soon realise that you will overshoot and fly well beyond the landing area. Good! You've set up the right approach on final.

Once you are 100% sure that you are going to overshoot the aiming point, then is the time to use the airbrakes. Almost all modern gliders have a glide angle better than 32:1. They are built to a standard which requires that the glider will have a glide angle no better than 7:1 with full airbrakes… that's a very steep glide angle.

Your airbrakes are very powerful and allow an enormous degree of control when landing. This is another way of saying, if you are not going to overshoot the strip, don't pull airbrakes!

Have a quick glance out along the wing just to confirm that airbrakes are out and the change of pitch and noise is not a wheel going up or change of flap setting.

Undershooting

If the aiming point is going upwards in relationship to the mark on the canopy, close the airbrakes immediately and check your airspeed. You may have a pang of doubt about undershooting on any landing, especially if there is a headwind of any strength.

What you must never do is try to stretch out your glide by pulling back on the stick. It won't work. As the glider slows, the sink rate increases and you will be on the ground sooner rather than later. If there is a significant head wind, speed is on your side and slightly increasing speed will mean you will spend less time in the headwind and it will therefore affect you less.

Nicely stabilised on finals with your aiming point stationary against the canopy. Airbrakes are half open. The windsock and lake indicate that there's little or no wind on the ground, so you are monitoring that the glider's airspeed is steady at 1.5 times the stall speed + half the wind speed. You're resisting the urge to fiddle with the airbrakes and getting ready for the round-out or flare.

When you are sure of an overshoot, gently pull on the airbrake handle to unlock the brakes. Have a quick glance along the wing at the airbrakes to see how far out they are.

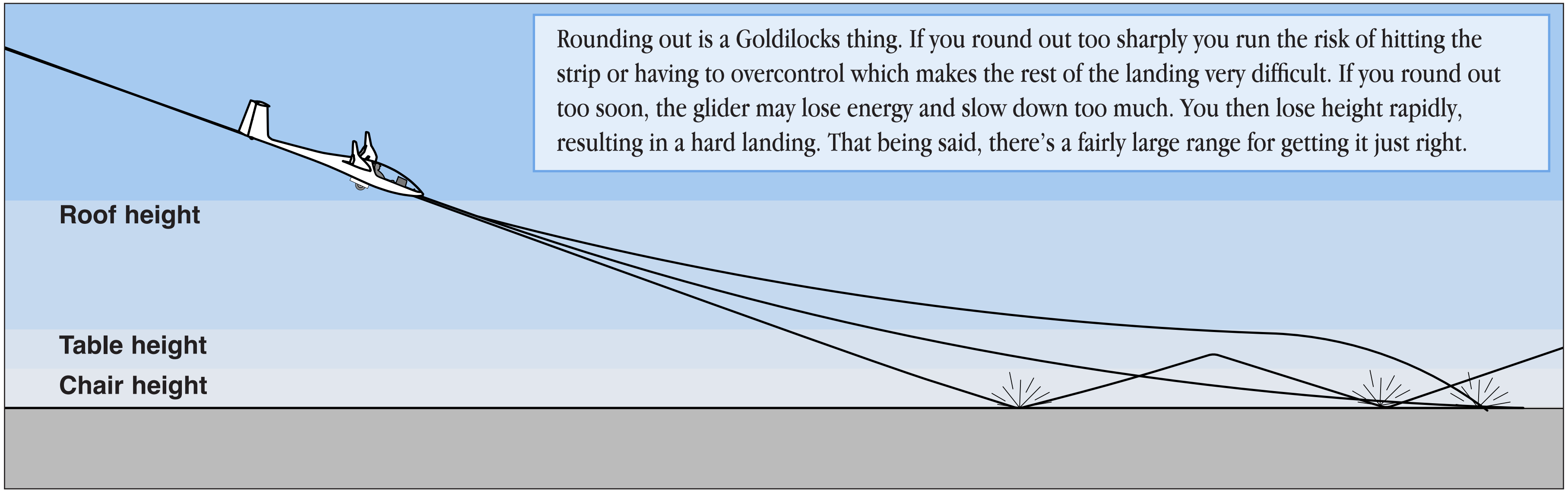
Ease them out and watch your aiming point. At the same time, keep glancing at the ASI to make sure you are maintaining your desired speed.

When the aiming point appears to be stationary against some point on the canopy in front of you, then you are correctly lined up.

Gliders lose speed when airbrakes are pulled out so be prepared to lower the nose at the same time as pulling the airbrake handle.

With the glider descending against the airbrakes, the speed of the glider can be easily stabilised so it will not try to rapidly accelerate or decelerate… as long as you resist the temptation to fiddle with the airbrake lever. If you are constantly adjusting the airbrakes, you will have a lot more difficulty maintaining the steady speed you want in a stabilised approach.

The round-out



Obviously, if you don't allow enough time on finals to achieve a stabilised approach, then it's more difficult to achieve a steady descent. That's what circuit planning is all about.

Make sure that on each leg of the circuit, you have time to complete the tasks you need without becoming overstressed. This applies as much to a short, modified circuit as it does to a standard circuit.

Good planning leads to good circuits and good circuits lead to good landings.

When you get more confident on finals, sneak a quick look out at the wing to see how far out the airbrakes are. Ideally, they'll be something like half way out which gives you maximum control.

If you close the airbrakes the glide path will flatten out and you will fly further down the strip. If you pull the brakes out further, then your glide angle will steepen.

It's not a good idea to get into the habit of landing with either almost full or almost no airbrakes. Flying your final approach with almost no airbrakes required means you've misjudged the conditions and you have left yourself little energy to play with.

At places where a lot of sink or strong wind gradients are common, the recommended practice may be to come in a lot steeper using more than half airbrakes and getting rid of excess energy with side slipping…there's more on side slipping later. You will find that a steeper approach is easier to judge than a shallow one.

By now, the ground is looming up and you're getting tense waiting for the right moment to ease back on the stick and round-out to level flight.

You might be relieved to know that there is actually no "right moment" to level out and there is quite a wide range of heights which are OK although a smooth and gradual round out is better on everyone's nerves than a sharp and jerky one.

To give you a rough idea, we'll talk about three heights… roof top height, table height and chair height. Roof top height is about the height to start rounding out. Ease steadily back on the stick until the glider is more or less at table height. As you do this, shift your eye line to the horizon at the end of the strip.

This is a very important point and one which is easy to forget later in your training… oddly, about the same time your landings start to go wrong.

We spend a lot of our lives looking straight out in front and it's a great deal more intuitive to assess height above the ground when looking towards the horizon than if you fixate at a point on the ground moving rapidly in front of you.

With the glider in more or less level flight at table height, the excess speed of the glider will begin to bleed off and the aircraft slowly sink.

As this happens, continue to gently ease the stick backwards letting the glider settle towards chair seat height. You've spent a lot of time sitting down and your brain will know where this is! This is the right height at which to hold the glider off until it gently settles onto the ground.

There's a lot of variation in how fast you round out, but the more steadily the better. Ideally, you ease the stick back in a continual steady movement from round out to touch down with only a slight pause at chair height so that when you finally touch down, the stick is almost fully back against the stop, the glider has not enough energy left to fly and it touches down as light as a feather. Well done!

But don't relax yet. As the glider rolls on the strip, keep the wings level as long as you can with the stick fully back to keep the tail wheel on the ground and hold the glider in a straight line with the rudder.

There's a risk that if you drop a wing or allow the glider to turn while it still has too much energy, the tail will swing round, you won't have enough rudder authority to control it, a wing will touch the ground and the glider will turn rapidly in a ground loop.

Ground loops can be very destructive and they are not that difficult to do, so keep everything straight and level until most of the energy has run off the glider.

Resist the urge to turn the glider towards the hangars or parking area if you're on the opposite side of the strip unless there's a good reason. There may be someone landing beside you and you could track right into their path.

Use enough airbrakes to allow the glider to roll to where you want to stop. There's a great sense of achievement when the glider stops exactly at the right spot, wings level and then one slowly drops to the ground.

In many gliders, the wheel brake is operated over the last few millimetres of travel of the airbrake lever so you need to be careful about pulling full airbrakes while the glider still has a lot of energy. The action of the wheel brake can pitch the glider over on its main wheel until the nose touches the ground. Hard braking wears out the brake pads unnecessarily fast and it's not unknown for a brush fire to be started by overheated brakes on a glider.

There's a saying which goes that when landing, you'll have one bounce for every spectator. Yes, it can take some of us a while to get our landings to a satisfactory level of perfection, regardless of the number of people watching.

We'll look at landing difficulties more at the end of this section. Right now, we'll go back and consider factors which might make takeoffs and landings more complicated.

Half Airbrakes

The purpose of the circuit is to arrive at the final turn in the right place, at a safe height and approach speed, and with safe alternatives always available. If you are in the right place at the start of the final leg, you'll only need half airbrakes to get to your aiming point, leaving you plenty of control over the approach.

How much is half airbrakes? Well, it may not be when the airbrake lever is half way back or where the airbrakes look as if they're half way out of the wing… half airbrakes is the position when they're 50% effective. You will find that a small amount of airbrakes showing will be more effective than the last 50% of airbrake travel.

Remember, that the airbrakes are for approach control. The elevator controls speed. If you're constantly fiddling with the airbrakes you'll find speed control with the elevator harder.

It's easiest to land with half airbrakes. Using too little will make the glider float further and make pitch control more sensitive and there's more of a chance of pilot controlled oscillation. Too much airbrake will give you less time to round out smoothly slowing the glider and making it harder to hold off properly.

Crosswind Landings

At some time, when you turn onto finals, things are going to look a little odd. It may take a moment to realise that the view outside the cockpit is moving sideways when it ought not to be… you're about to make a crosswind landing.

Of course, you looked at the windsock and at all the normal signs of wind like cloud shadows on the ground, drifting smoke, dust, ripples on dams and understood that the wind on final approach would be cross but now the world is moving sideways, you are ready to pay closer attention.

If you ask pilots with a reasonable amount of air time, how they handle a crosswind landing, most won't talk about what follows here, they'll say 'I just fly the glider.' And that's how it is. As you get more experienced, you'll almost certainly just fly the glider without thinking about the mechanics and movements behind crosswind landings.

Choose the landing approach which has the least crosswind component approach rather than the most convenient one.

A crosswind component will change the time you spend on base. You may be able to fly base into the wind and have more time. If you fly a base leg with the wind component behind you, it's going to take less time and you might be want to fly the downwind leg further out from the landing area.

Keep in mind from which direction the wind is blowing… or over which wing the wind is and how this will affect the glider on final approach, touchdown and the roll out.

There are two main methods of flying a crosswind landing though most pilots will use a combination of both and may be unable to explain exactly what they're doing.

Crabbing crosswind landings

After the turn onto finals, the glider is yawed slightly into the wind with the rudder, wings held level, so that though the nose of the glider may be aiming off the strip, the track of the glider is straight towards the landing area. With this method, the view of your aiming point will be slightly off to one side but should still remain stationary in relationship to a reference point on the canopy.

The round-out and float is flown normally and just before touchdown, enough rudder is used to yaw the nose of the glider to align with the track, wings held level, so that as the wheel touches, it doesn't have any side load.

Crabbing approaches are good in strong winds but you need good judgement to use the rudder at just the right time before touchdown.

Wing down crosswind landings

With the wing down method, the glider is flown on final approach with the into-wind wing held low and sideslipped with bank and opposite rudder. In practice, the amount of sideslipping appears very slight so it may be an easier way to fly a crosswind landing at first.

With a wing down crosswind approach, you're looking over the nose at the strip and the picture should appear to be quite normal unless you look out at the wing or down at your feet. Just before touchdown, roll the wings level so the wingtips are clear of the ground.

Whatever way you choose to fly the final approach, don't relax until the glider is stationary with the into-wind wing on the ground.

Keep the glider rolling straight after touchdown and be ready to use full rudder if the tail shows any tendency to swing out into a ground loop. Keep the into-wind wing low through the roll out and try to lower it to the ground as the glider stops to prevent the glider blowing over.

The wing down method is suited to landing across sloping ground when the wind blowing up the slope, as the bank angle gives more wing tip clearance.

In windy conditions, you can expect a stronger wind gradient. The corrections needed to keep the glider tracking where you want it on final approach will need to be adjusted as the wind strength and direction changes near the ground.

If the wind is strong, consider landing slightly across the strip. This isn't always possible, but if you expect over 20 knots on the ground, your speed through the air is not going to be very fast at touchdown and you roll out short.

Wind at low altitude

If the wind is always straight down the strip and you always take off and land directly into it, you are lucky. Stay at that airfield! Mostly however the wind strength and direction varies constantly through the day and can even switch by 180º if a thermal pops off on the strip.

To begin with, you will probably only take off and land in light to moderate winds, but soon you will want to fly when the wind is stronger. Modern gliders are increasingly heavy and one of the good things about this is that they are not affected by wind as much as lightweight gliders, but the wind can still make things interesting.

Cross wind takeoffs and landings are covered elsewhere in some detail. There are a couple of other things to watch out for caused by cross wind turbulence.

- If the strip has trees down the side of it, and many do, they can generate mechanical turbulence in a cross wind which is felt at distances well over 30 times the tree height away.
- The energy in a wind-gust is related to the square of the wind speed so mechanical turbulence near the ground becomes very much stronger as the wind speed increases.
- Low level turbulence is something you should always be prepared for on a windy day.
- When winching, don't rotate into climb too fast if there's a chance of low level turbulence.
- On aerotow, don't stay too close to the ground after separation.
- On landing, fly with a little extra speed near to the ground to give you better control.

Wind gradient

Wind speed increases with height, and this gradient effect is mostly felt in the lowest 500'. Low down, friction with the ground and energy lost through mechanical turbulence slows the wind down. The gradual change in wind speed with altitude is called the "wind gradient," and it is something else to be watched out for, particularly when landing.

Imagine a glider flying into a strong headwind in a steep descent on finals. As the glider descends, the headwind reduces closer to the ground and in a few seconds, the glider is flying into a headwind which is remarkably less strong causing a loss in airspeed. The glider has some inertia and it can't accelerate rapidly to cope with the decrease in headwind and the pilot finds the glider is now flying far too slowly.

A drop in airspeed means more lift is required to keep the glider flying which means more drag and more sink. Unless the pilot has started on finals with an adequate excess of speed, they may now find they no longer have enough height to make the strip. At best, the round-out will be made too slow and the result will be a very heavy landing.

Gliders with a big wingspan can be affected by wind-gradient when doing turns close to the ground. Their span is such that the wind speed on the high wingtip may be quite different to the wind on the low wingtip.

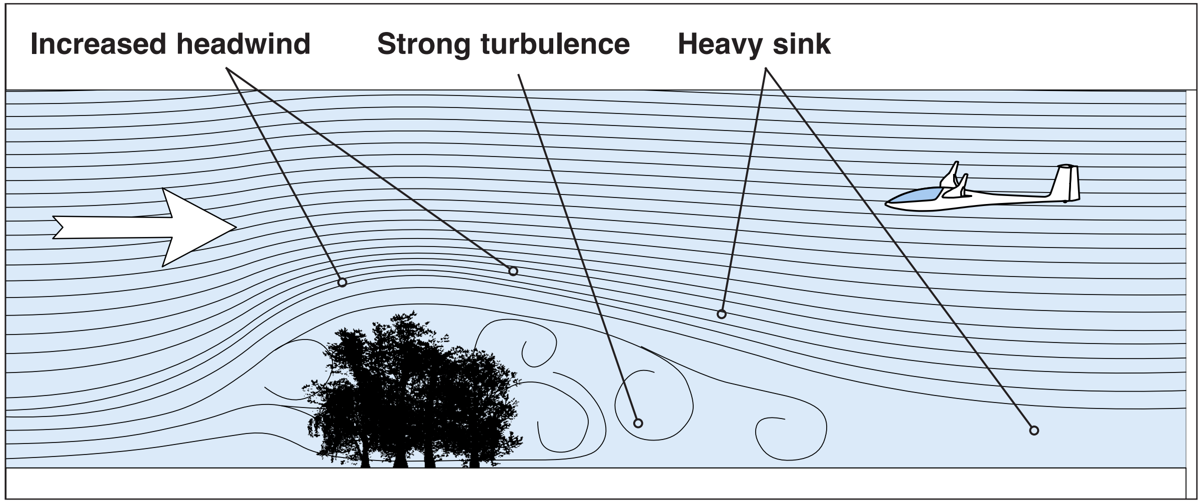
Loss of airspeed low down on final approach must always be anticipated in windy conditions and you should be on the lookout to make sure that the speed you had at the top of your descent is maintained until your round-out.

When launching, especially on a winch or aerotow, be very careful of wind gradient. The wind gradient will make recovery from a low altitude cable break a lot more difficult because the glider will be slowing down as it descends through the wind gradient close to the ground.

If you think that wind gradient might be more on a gusty day, you would be wrong. Oddly, on days which appear calm low down, layers of air are able to slide across each other than on days where the lower levels of air are being stirred up due to gusts or thermals.

Trees can create a lot of turbulence or rotor. Rotor coming off lines of trees beside a strip can give some exciting takeoffs and even more exciting landings. We're perhaps not so aware of the effect that a line of trees can have when they are directly in our flight path, especially on low final.

When looking at the way trees affect the wind, there are three main variables. The height of the trees, the wind speed and the density of the tree barrier. The relationship between these factors is interconnected so that the higher the tree barrier, the further upwind and downwind their effect will be felt, so most calculations are related directly to tree height.



Flying low over trees

At low wind speeds, less than 8 knots, the air flow over obstructions is fairly laminar and there is little energy in any rotor that a tree line may produce.

If you are flying over a tree line on low final in winds less than 8 knots, a sparse tree barrier will provide little change in wind speed, little change to the airflow over the barrier and therefore little turbulence.

As the wind speed increases, the energy increases exponentially. Anyone who has launched from a cliff site in a hang glider will confirm that taking off between trees or bushes at 10-12 knots is fairly trivial but at wind speeds of over 20 knots, it is anything but trivial.

If you have successfully flown over a line of trees in 10 knots, do not expect the air conditions to be the same at 20 knots and more. Be exponentially more cautious.

We've looked earlier at the effect of wind gradient over a runway and the way that the wind speed becomes slower as it gets closer to the ground. We maintain a safe airspeed of about 1.5 times our stall speed plus half the wind speed because of this.

However, what happens to the wind gradient over a rough surface like a field with crops or the tops of trees, is considerably more extreme.

Over a normally smooth grass strip, the wind speed increases by a factor of 1.4 between 3 and 30'. If you have 10 knots at 3', you can expect 14 knots at 30'. Over a long grass or cropped field where the surface is rougher, the wind speed increases by almost 2 times. This means your 10 knot wind has increased to 20 knots at 30'

A line of trees is significantly rougher than a field! To allow for the big increase in wind gradient over trees, especially in strong winds, it would seem prudent to either make sure that you overfly with significant height to avoid the worst of the gradient, or that you add more than half the wind speed to your safe speed near the ground.

It makes sense to treat a moderate to dense tree line as if it was a hill when overflying it in moderate winds and fly at least twice the tree height above to avoid the effect of the trees. In a strong wind, allow more vertical separation than this.

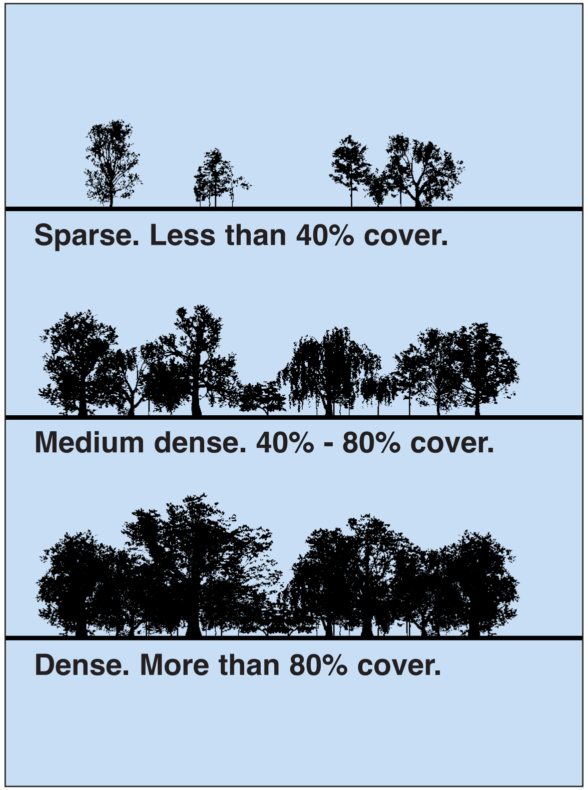
The density of the tree barrier is the third significant factor in assessing the effect of trees and can be divided into three broad types.

• • A sparse or open barrier where there is less than 40% tree cover.

• • A medium dense barrier where there is between 40 and 80% cover.

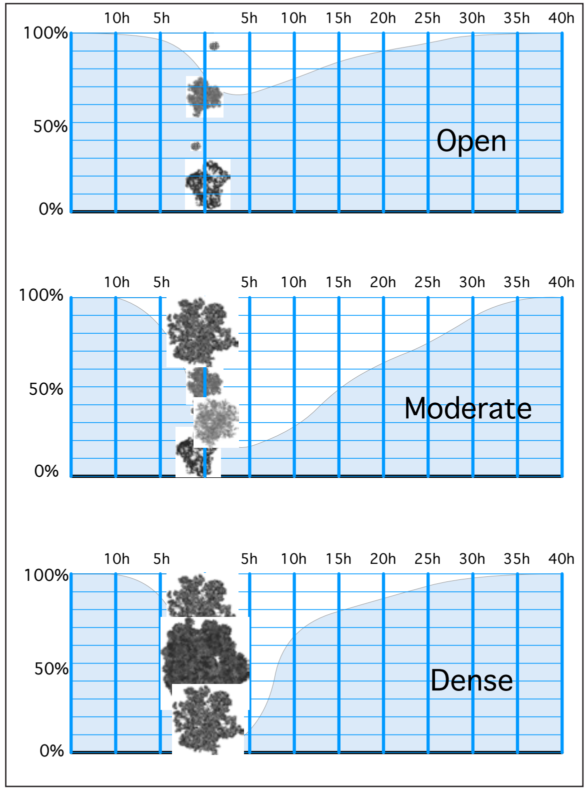
• • A very dense barrier where there is between 80 and 100% cover.

It's the medium and dense barriers which present difficulties for sailplanes in terms of over-flying a tree barrier on final or landing on a field bounded by dense trees.



Landing in fields near Trees

The graphs above show in the way wind speed varies with distance from a barrier. The barrier is shown in plan view and the graph shows wind speed on the Y axis against distance on the X axis. The horizontal or X scale of these graphs is reduced and is about 1/10th the scale of the vertical axis.



A tree barrier will affect the wind speed both upwind and downwind. The biggest effect is downwind of the tree line and it's not until about 30 times tree height that the effect ceases to be significant.

Putting this into real numbers, an average 15 metre high tree barrier will be felt 450 metres downwind… almost half a kilometre.

Closer to the tree line there will be increasing sink, wind gradient and turbulence. Overhead the tree line, there will be a compression zone with increased wind speed relative to the height and density of the tree barrier.

The dense tree barrier behaves as if it was solid and at ground level, the wind speed close to the tree line will be close to zero. Further away from the barrier at around five times the tree height, gusts are caused by rotors from above.

Because wind filters through a moderately dense tree line, it behaves slightly differently to a very dense tree line and the lowest wind speed is found some distance further away. In fact, the overall reduction in wind speed is greatest with a moderately dense barrier.

With less than 40% tree cover, the effect on wind speed is minimal with the low point being about five times tree height away from the barrier.

With a moderately dense barrier, there is some wind immediately behind the trees and the greatest overall wind speed reduction. Wind speed reaches a low point five to ten times tree height away.

A very dense barrier will have almost zero wind immediately behind itself but the wind increases more rapidly with distance. In the near zone from 0 - 10% tree height, significant gusts can be expected.

If you are landing on an airstrip or outlanding in a field bordered by a sparse or open barrier of trees, only a small drop in wind speed will be felt about 5-10 times the tree height back from the tree line. But if the barrier is dense or moderately dense, you need to make allowance for the effect of the trees on the wind.

As a final note, for its own personal reasons, wind prefers to travel around barriers rather than over them. Friction over the barrier also changes the direction of wind so that the wind blowing over a barrier is turned closer to straight on. This means that the wind at the ends of barriers may not only be stronger but the direction will be different.

If you are landing in fields surrounded by trees in moderate to high wind, you need to be aware that an approach over trees or a landing towards a tree line will be affected. Because of the speed and mass of sailplanes, many of these effects can be ignored for much of the time, but if the wind is stronger than normal, be prepared!

It is a fairly alarming feeling to think that you are about to grease it in over the tree line and find that at the last moment, you are suddenly dropping towards them… or to have made a perfect approach and be rounding out nicely only to find that the wind speed has suddenly dropped and you are approaching a stall or a hard landing.

A downwind leg in a strong wind can be quite exciting as you see your landing area zip past unnaturally fast, but that's a reminder to reassess the wind direction and speed and if necessary make an adjustment to your plan.

If you fly a diagonal leg between downwind and base, you will have plenty of time to adjust your position in relationship to your chosen landing point and make sure that your final leg over any obstacles is flown safely, with plenty of height.

Side Slipping

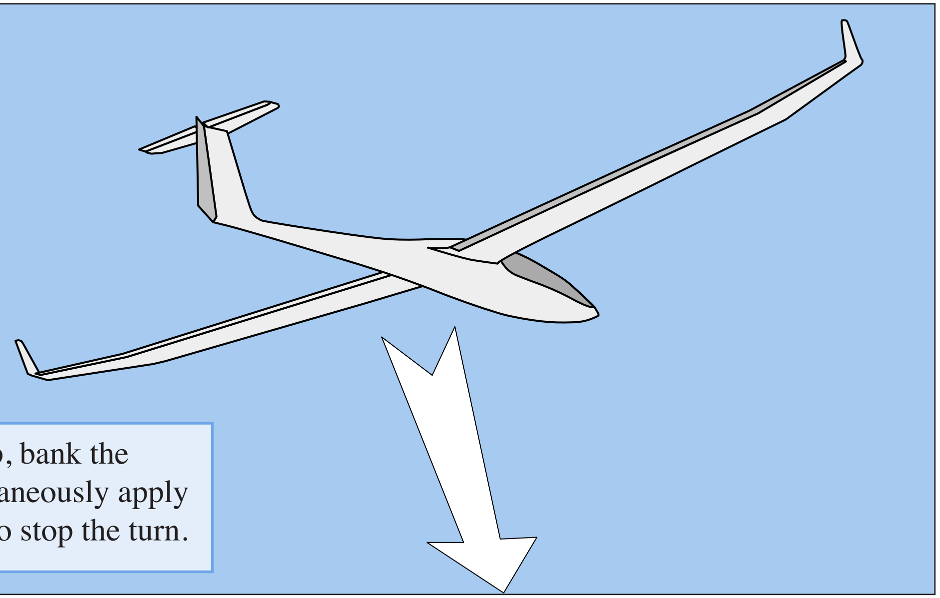
A side slip is a manoeuvre where a glider is flown slightly sideways relative to its direction of travel. The purpose of a sideslip is to create additional drag from the fuselage and fin without increasing airspeed. Sideslipping is sometimes used to lose height before landing.

While you need to learn about sideslipping, it's a technique which does not apply as much to modern gliders as it does with older glider designs. As mentioned earlier, gliders are required to have airbrakes which will reduce the glide angle to 7:1. Many gliders have airbrakes which are much more effective than this so sideslipping is unlikely to be needed.

In any case, sideslipping should learned with an instructor and used with caution. In some gliders, sideslipping at low altitudes can be dangerous The action of side slipping causes turbulence which blankets the elevator and the glider can pitch nose down.

In other gliders, the rudder is sucked sideways and may require a positive effort to straighten it up and stop the sideslip. This may be noted in the glider's flight manual.

Most modern glider designs are heavier than old designs and heavy gliders may be difficult to snap out of a side-slip compared with older gliders.



To start a sideslip, bank the glider and simultaneously apply opposite rudder to stop the turn.

• Don't use sideslip in a landing approach unless you can do it smoothly, accurately and return to level flight smoothly too.

• Don't sideslip close to the ground. If you sideslip during a landing approach, make sure you have returned to normal flight well before rounding out.

To get proficient enough to be able to use side slipping during a landing approach, you need to able to enter a sideslip rapidly and leave it at will and this means you must practice at altitude to get it right. Many instructors learned in older gliders and have a lot of experience side slipping, so practice with them!

An ideal place to practice is if you arrive back at the strip with excess height and you want to lose it before joining the downwind leg.

Start a sideslip by slowly banking the glider and at the same time, apply opposite rudder to stop the turn.

You may have to apply a little back-stick to keep the nose at the right attitude. You can then apply more aileron and rudder progressively to increase the side slip.

The size of the rudder will be the limiting factor in how much a glider can be sideslipped and how much height you will lose.

The result may be slightly disorientating at first because the glider will be descending in a yawed condition and you'll have to look out sideways in the direction of travel. Keep a close eye on the ASI. Many gliders will give a false airspeed reading when yawed in a sideslip.

When you are proficient at side slipping, you can try with airbrakes. Pull full brakes (or why else would you need to slideslip?) and then progressively apply sideslip. Don't pull airbrakes while in a sideslip unless it is approved in the glider's flight manual. A glider's stall characteristics change when airbrakes are out.

Typically, a sideslip will be used on the early stages of a final approach when it's clear that full airbrakes are not going to be enough to get the glider to the aiming point.

As soon as this is recognised, the slideslip must be entered. And as soon as it is apparent that enough height has been lost, the sideslip must be stopped and the glider flown in a normal final approach with half airbrakes.

Launch and Landing Emergencies

Part of being a complete airman or woman is being able to competently handle anything which might not go completely according to plan. These events are grouped under the heading of "emergencies".

The sport of gliding has being going on for more than 90 years and since humans are so good at finding new ways to get things wrong, the safe way to deal with almost all emergencies was worked out a long time ago.

Most emergencies are not really emergencies… more occasional routine variations to the normal… but in any case, we should always be prepared for any of these variations especially in the takeoff and landing phases of a flight. Forward planning, mental rehearsal and always keeping in mind the possibility of these events happening on any flight will prevent them becoming emergencies.

Launch emergency options should be mentally rehearsed before every take off so that sudden decisions are not necessary. So the following discussion should be something you think about before every launch in your pre-launch checks.

The importance and usefulness of mental rehearsal in sport cannot be stressed enough. There's a heap of proof that properly done, mental rehearsal is almost as good as the real thing. Think of your brain as an advanced but low-cost flight simulator!

Non-manoeuvring area (NMA)

During any takeoff, there may be a point when, if the winch, tug or self-launcher's engine loses power, the glider is not high enough to turn back to the strip but is too high to land straight ahead. This is called the non-manoeuvring area or NMA.

Avoid getting into an NMA.

All aircraft on a particular airstrip, have a non-manoeuvring area. Even a jumbo jet, thundering down the runway has at some point got to commit to a take off, because there is no longer enough runway ahead on which to stop.

The non-manoeuvring area's lower boundary is defined by the height at which you can no longer land straight ahead and its upper boundary by the height at which you can easily turn and make a modified circuit to land back on the strip.

The invisible boundaries of the NMA will vary depending on the strip, the launch method, the rate of climb during launch and the prevailing wind etc.

When you do your CHAOTIC pre-launch checks, the non-manoeuvring area is something you should consider and plan for in the "Options" section. You should work out the point at which you abandon a take off in the event that the glider looks like entering the NMA and when the glider has enough height to be clear of the NMA.

During the launch itself, it's a good idea to talk through the options, aloud or in your head, so you are fully prepared to carry out your Options plan and equally, can retire the plan when you are well clear of any non-manoeuvring area.

Launch emergencies

Before getting into the specifics of launch emergencies, consider this. Landing ahead is always the best option and should always be your first thought because it involves the least thinking. On most strips, especially when you are winch launching and the climb rate is high, 300' AGL should be enough height to do a modified circuit, and it will almost certainly give you enough runway to land straight ahead.

If you have enough height to complete a safe return to the strip, then you need to maintain a good look-out and watch your airspeed while manoeuvring. At busy clubs, during competitions or where dual operations are in progress, there may be other traffic in the circuit area or in the early stages of takeoff.

In the event of a 180º turn-back, you may be landing downwind. Get the glider on the ground early because your ground run will be longer than normal and be aware that ground loops are more likely when landing downwind. Never attempt to prolong your glide back to the launch point for the sake of convenience.

Several types of emergencies can happen when you are taking off, but to begin with let's categorise these into events which happen before you are airborne and those which happen after you are airborne.

Launch emergencies on the ground

If the glider is still on the ground, irrespective of the launch method being used, be prepared to pull the cable release in an emergency. This means having your hand close to or covering the release handle at all times during a launch.

Occasionally, with all types of launches, it happens that the glider rolls over the cable or rope. This can happen if the slack is taken up a little too fast and there's some hesitation when full power is applied. The risk here is that the glider may roll over the cable and the cable become hooked onto some part of the undercarriage.

It's most important that you do not allow the glider to fly. This applies equally if you are the pilot or a member of the ground crew. The Stop! command should be given clearly and loudly.

If you are the pilot, release immediately. Give the release two firm pulls. Push the stick fully forwards and pull out the airbrakes. If you are the wing runner, quickly put the wing on the ground to alert the pilot and other launch crew.

Launch emergencies in the air

When the glider is airborne, especially low down, you must always make sure the glider is flying at safe speed near the ground (and that means any height below 1000' above ground level) is at least 1.5 times the stall speed (1.5 Vs).

Make sure you have read and fully understood the section on Safe Speed Near the Ground and it's full implications. You must make absolutely sure that the glider is stable at this speed before attempting any manoeuvre, especially a turn-around to attempt a landing.

If you pull back on the stick or bank into a turn, the wing loading of the glider will increase and the stall speed will go up. On almost all gliders, when you pull on airbrakes, the stall speed will also increase by 3 or 4 knots. If you were close to a stall before you started these manoeuvres, you will be a lot closer afterwards.

Most emergencies happen quite slowly (certainly in retrospect!) You will almost always have time to think before you act and if your basic instinct is to make sure you always have safe speed near the ground whenever an emergency occurs, you will not go far wrong.

Winch cable breaks & launch failures

Airspeed close to the ground

A cable break is a sudden event and you will almost always see, feel or hear it. However if the tow vehicle or winch has a gradual loss of power, you will not always realise it right away. However if you are on top of things, when a gradual loss of power does happen, you're continually monitoring your flying speed and making sure it is never below 1.3 Vs and you'll automatically lower the nose to maintain safe airspeed.

Don't rely on your senses to tell you how fast you are flying, especially your eyes because they will all tell you lies at some time or another! Get into the habit of having a quick glance at the ASI every four or five seconds in the critical stages of taking off and landing. How can your senses lie? There are many ways, but here are just two which can catch out even experienced pilots.

Suppose you have to make a downwind landing in a moderate wind… because of a launch emergency or because you have run out of height when returning from a soaring flight. The wind is moving your glider over the ground and when you are low down and can see things like trees moving past, your eyes will tell you that the glider is flying faster than it really is. There is normally a terrific urge to pull back on the stick to slow the glider down. Your senses are lying and only the ASI will tell you how fast the glider is going through the air.

How about in winter or after a wave flight… You've got used to flying with the vents open in the glider in warm weather and one of the clues you have unconsciously learned which tells you how fast the glider is flying is the noise level in the cockpit. Now it's cold and the vents are closed, you have lost these cues. Only the ASI will tell you how fast the glider is going through the air.

You may say "Oh, but I can tell by the nose angle, by the attitude of the glider to the horizon". Yes, but with flapped gliders the nose angle does not change so much with speed. With many types of gliders, pulling airbrakes changes the attitude so you have to recalibrate your idea of speed related to attitude. And what about flying in the mountains where there is no normal horizon line to base your attitude on?

The ASI is not infallible, but it is, in almost all cases, better than your senses! In the early stages of climb after launch by winch or by the time you are turning onto the final leg of your landing approach, there should be little chance of other traffic in your way so you can slightly modify your normal lookout.

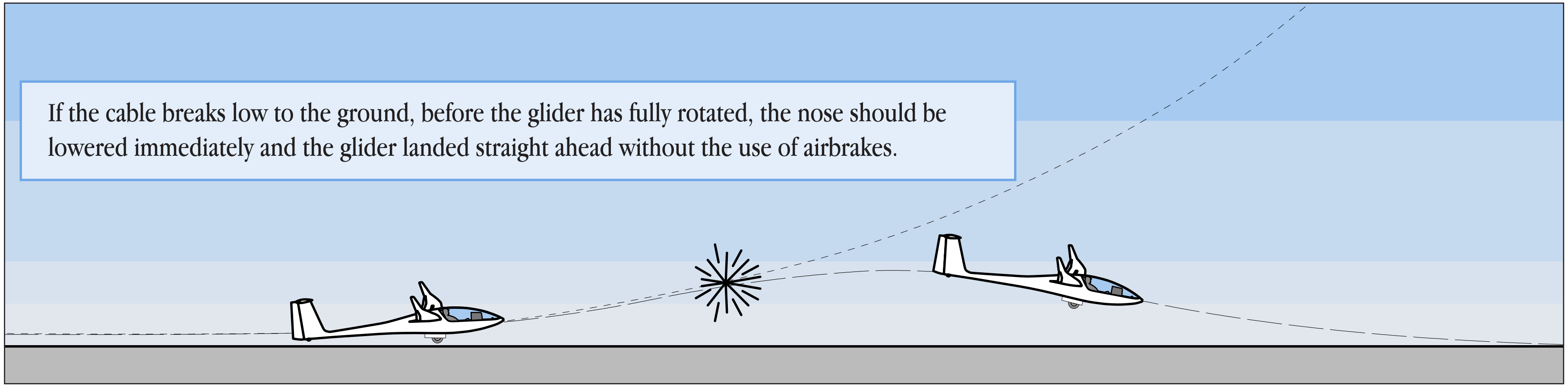
Get into the habit of glancing quickly at the ASI every four or five seconds to check your airspeed during these stages of a flight.

Non-manoeuvring area (NMA)

When winch launching, the glider normally climbs so fast that within a very few seconds you have room to manoeuvre. You can choose to land straight ahead or do a modified circuit.

If for some reason the glider does not climb as fast as normal and gets pulled down the field without gaining much height, then you may approach a situation where there is a real NMA. You have not enough height for a modified circuit and not enough room to land straight ahead, the only other option might be to land outside the strip… and in some cases, this is not an option.

Obviously, you have planned for this situation in the Options section of your pre-launch CHAOTIC checks . If you are aware of a launch problem such as failure to climb rapidly don't hesitate, release immediately, land straight ahead and don't enter the non-manoeuvring area.



Winch Cable Breaks at low altitude

If there is a cable break or weak link failure close to the ground when winch or car launching, there will be no time to release the cable. Lower the nose to a attitude suitable for landing and land straight ahead, without airbrakes.

If there is a cable break at a slightly greater height when the glider has already rotated into a steep climb, you will have only a short time to get the nose down and airspeed up. Perhaps only 1.5 seconds in older, slower gliders. The most critical moment for a break is when the glider is rotating into the climb and is at a steep attitude to the ground.

Because of this nose up attitude, the glider is going to lose speed very quickly and the nose should be lowered immediately with conviction.

That's the reason why:

- You control the glider so transition into climb is gentle.
- Why it should take at least six seconds to rotate from level flight to the full climb attitude
- Why the flying speed before rotation should be at least 1.3 times the glider's stall speed.

A safe recovery from a low cable break requires energy. If you have a cable break with the glider in a low climb, the nose-up angle of the glider means speed and therefore energy will drop off very fast so you *must* push the glider into a nose-over manoeuvre immediately.

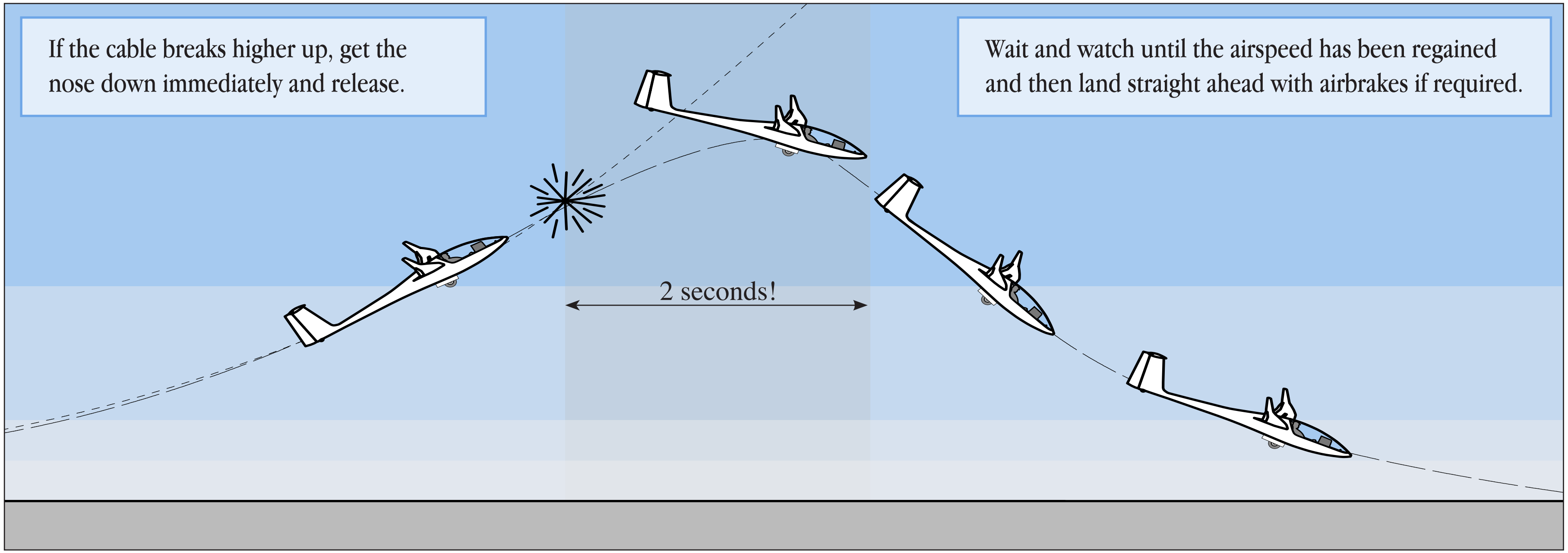
This push-over should be positive enough to give you a zero-G lift-up in your seat.

After the push-over, the glider should be held in a shallow dive until the airspeed has built to a safe flying speed. The best attitude in which to hold the glider is about 15° or the same as a normal landing approach.

Hold the glider in a dive so that it accelerates and check the ASI to make sure your airspeed is at a safe speed before making any control movements.

Don't pull on airbrakes. Apart from anything else, in an early launch emergency there should be a long length of runway in front of you so airbrakes won't be needed right away.

Remember, pulling airbrakes will increase the stall speed of the glider and will stop it accelerating to a safe flying speed.



When you have time, firmly pull on the release cable twice to make sure you are not still connected to a length of wire which may hook on something.

Of course, it goes without saying that you should expect a cable break every time you launch and have mentally rehearsed a cable break. This way, if a cable break happens, you will not be taken off guard, but will get the nose down firmly but calmly, wait for the airspeed to build and then release the cable.

Winch Cable Breaks at mid altitude

If you have a cable break from higher up, there's normally a lot more time to evaluate the situation. Your first priority, as always, is to attain safe flying speed. And then you can put into action one or other of your emergency plans. Of course, if there is enough room to land straight ahead. This is always the preferred option.

During your pre-takeoff checks, you will have rehearsed a few emergency options and got them sorted in your head. Many pilots will then talk their way through these on takeoff… counting through the options as the takeoff proceeds, the glider gains height and the runway ahead gets shorter.

"Straight ahead… straight ahead… straight ahead… enough height for a 180°… 180°… modified circuit… modified circuit… and so on.

If you do this regularly, then it's unlikely you will get caught out and not know what to do if there is a real launch emergency.

There are so many variables in launching… runway length, wind strength and direction, winch or tug power, glider weight, the surroundings at the strip, trees and buildings etc. that it's impossible to give hard and fast rules about every situation. However, some things are worth bearing in mind.

• Turns should only be made after you have safe airspeed.

• Landing straight ahead is normally the first option to consider. If this is no longer possible…

• A well-banked turn uses less height than a shallow one.

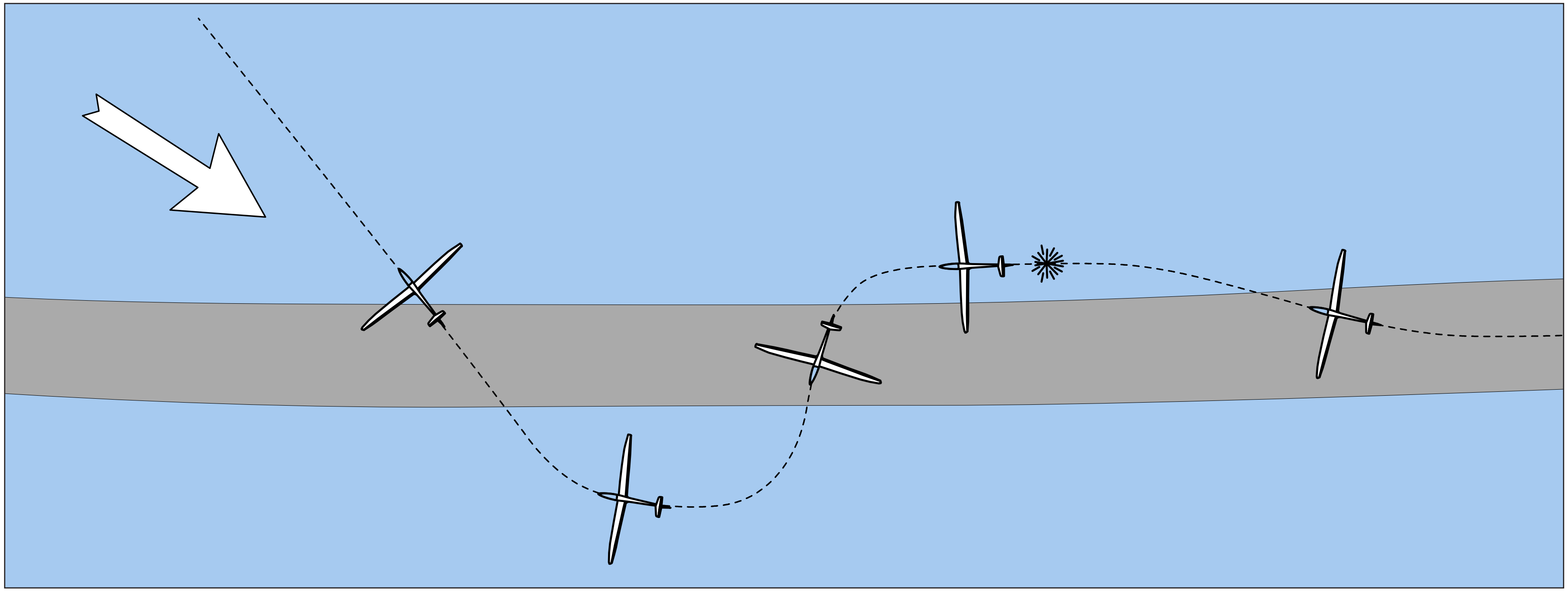
With any cable break the rules are:

• Attitude… Lower the nose smartly to below the approach attitude.

• Airspeed… Visually confirm from the ASI 'safe speed near the ground plus half wind speed' and don't turn or open the airbrakes until the approach speed is attained.

• Assess… Can I land straight ahead or do I need to select an alternative landing area?

• Act. Good pre-flight preparation will make this seemingly complicated task much easier.



In the scenario above, there is a moderate cross wind. The glider has launched and is banked towards the windward side of the strip so the cable will drop in the best place for the cable retrieve. Then the cable breaks.

The pilot smartly lowers the nose, waits until the airspeed builds and then pulls the release twice, at the same time, looking out to check the runway ahead and the available height.

The pilot realises that there's not enough room to land ahead but, as planned earlier, there's enough space off to the windward side of the strip for a safe touchdown. As soon as the glider has attained a safe airspeed, it's banked away from the strip.

The reason for this is that the wind will push the glider further away from the strip as it turns and give a greater distance between the strip and the glider in the available time. If the glider turned into the wind, it would move more slowly into wind and not make enough headway for a safe cross-strip landing.

The pilot keeps a good eye on any trees or obstructions at the edge of the strip and regularly looks back to check the eye-line angle to the airstrip and pick an aiming point.

When the angle is looking good, the pilot makes a well banked turn towards the strip and if the aiming point is moving down, pulls airbrakes and lands normally.

Since the cable break, the glider has done less than 270° of turning.

Almost any other scenario will result in an S turn or a full circle, both of which are 360º… think about it… the S turn is four 90º turns. So under these particular conditions, this is the safest and easiest option.

Most Australian gliding sites are large and cable breaks are less critical than on smaller airstrips. During training, everyone has to fly a few launch emergencies. It's often possible to see the instructor and winch driver or tuggie planning them but don't be too sure about this!

One thing which normally comes out of these practice emergencies is that things happen quite slowly and though you might crank the glider round as soon as it is flying fast enough to land back on the strip, there's a lot of height still to get rid of.

If the airstrip where you fly regularly is fairly long, it's a great idea to pick a point some way along the field and then try a few full airbrake landings to see just how steeply the glider does come down and how little runway is actually used up by a full airbrakes, straight ahead landing. If you do try this, be sure to ease in the airbrakes before rounding out to avoid a harder than normal landing.

Rope breaks on aerotow

If you have a rope break when aerotowing, again the first thing to do is to make sure you are flying at a safe speed, Safe speed near the ground. With aerotowing, the attitude of the glider is a lot more normal than when winching, but you will still lose speed quickly unless you take action to maintain it.

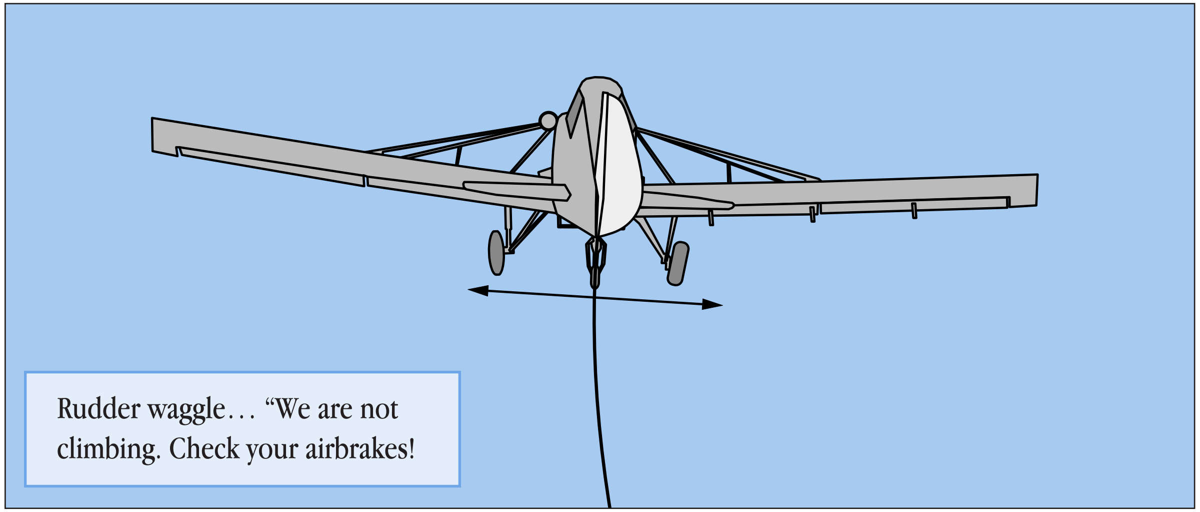
Unlike the belly cable hook, the nose hook doesn't have a back release, so you should pull twice on the cable release to get rid of the tow rope because you don't want it hook up as you cross a fence or trees when you are concentrating on landing.

When aerotowing, as with other forms of launching, if you are low, the safest option is always to land straight ahead. Only if you are absolutely sure, make a modified circuit to land back on the strip.

What to do when the launch speed is too low.

If the launch speed is too slow or if there's a gradual loss of power rather than a cable break and you are actively monitoring your airspeed you will probably have time to think and consider your options.

The first thing to check is your airbrakes. Are they really closed and locked? Even slightly open, airbrakes will dramatically affect a launch.



Rudder waggle… "We are not climbing. Check your airbrakes!

If the loss of power is only short, you might be tempted to continue with the launch. Don't! The safe option is to release before you get too high and enter what is called the Non-Manoeuvring Area (NMA).

Non-manoeuvring area (NMA)

All aircraft on a particular airstrip, have a non-manoeuvring area. Even a jumbo jet, thundering down the runway has at some point got to commit to a take off, because there is no longer enough runway ahead on which to stop.

The non-manoeuvring area's lower boundary is defined by the height at which you can no longer land straight ahead and its upper boundary by the height at which you can easily turn and make a modified circuit to land back on the strip.

When aerotowing, if the rate of climb is lower than normal, the tug pilot may wag the rudder of the tug from side to side. This is a signal for you to check the airbrakes to make sure they are fully closed.

If they are fully closed and there's nothing else abnormal with the glider, remember that the tug may release the glider at any time afterwards without warning so be prepared.

If any launch, whether winch, aerotow or self launch, is too slow or there's any chance of the launch not proceeding safely, release and abort the launch immediately.

Land straight ahead while you have plenty of time… and if possible, to the right of the tug. Don't hang on hoping things will get better, because they may not. This is of the utmost importance where airstrips are surrounded by trees and do not have good emergency areas at the ends of the strip.

What to do when the launch speed is too high.

It's unlikely that a glider and tug combination will be much too fast, unless the glider is very light. In almost all cases, the glider can be trimmed a little faster, the stick held further forwards to keep the glider in formation with the tug or call to the tuggie on the radio to ask for a reduction in speed.

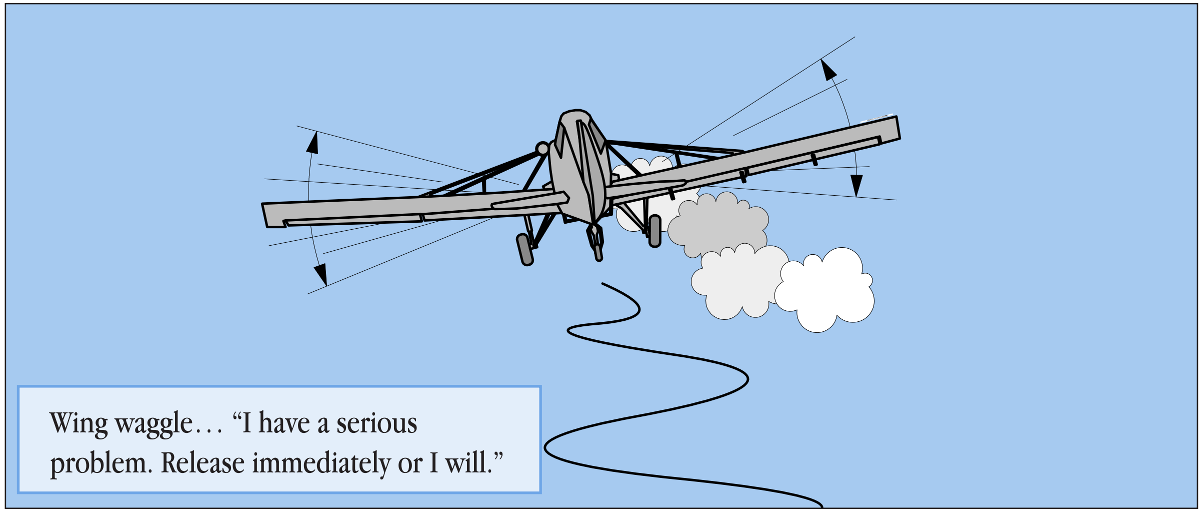
However, almost all winch and car tow launch systems are powerful enough to be too fast for some gliders. As we noted earlier, this is not a problem in the early phase of a launch but it is a problem towards the top of the climb so you must have acted on any excess speed well before then.

If the speed is too high early in a launch, you will have more time to think and more options compared to a launch when the speed is too low.

In most cases, the easiest thing to do is to attempt to contact the tug, tow vehicle or winch by radio and ask them to back off the speed a little. If the strip is not flat, the winch driver may not be able to see the glider and radio may be the only option.

If there's a reason you cannot use radio then the pilot can give a "too fast" signal. To give this signal, you yaw the glider from side to side with the rudder while keeping the wings level with the stick. The yaw manoeuvre should be as precise as possible so it cannot be confused with the normal slight weaving of a glider on the winch. If the glider is flying fast, there's only so much rudder you can use without risking over-stressing it.

If the launch speed remains too high, climb as gently as possible to a safe height before releasing and landing straight ahead.



Failures with the tug aircraft.

Tugs can fail and you should always be anticipating this. There are two main types of failure… gradual and rapid.

If the tug has a rapid or sudden loss of power there's no warning and little either pilot can do other than release immediately. The tug pilot may pull the release from the tug end or you may release at your end, but don't delay. The tug hasn't got anything like the glide angle of a glider and will disappear downwards very fast.

If you are low, make a straight ahead landing as described above. If you are high enough, make a normal modified circuit or find a thermal.

If the tug has a gradual power failure or the tug pilot believes this is likely to happen or if there's a problem with the engine, the tug will give you a clear wave off signal. The waive-off signal is given by the tuggie rapidly rocking the tug's wings from side to side.

This is a much more rapid movement than normal rocking of the tug's wings on tow due to turbulence. If you see the tug making this signal, release immediately. Don't delay. If you do delay, the tug pilot will release the glider.

What to do if the cable release fails.

Modern cable releases are very reliable and release failures are very unlikely. Occasionally, you may need to pull twice on the release to guarantee the hook letting go, especially if there's no strain on the rope or wire. Two pulls should always be done when releasing from a winch launch and in the case of any launch emergency.

The belly hook has two releases. One is actuated by you pulling on the cable release handle. The second release is a back release which operates automatically when the tow cable is approximately at 90^{o} to the fuselage of the glider.

When winching, if you don't release, the cable should release by itself.

In spite of this, there may be rare occasions when you find you can't release. When winching or car towing, the operator of these vehicles will cut or release the cable at their end. Most winches are fitted with guillotines for cutting the cable. Because the cable is still hooked onto the glider, it must now be flown in descending circles within the cleared area of the strip until the glider is low enough that you can straighten out and land with the cable still attached.

If the glider release fails when aerotowing, the tug pilot can release the rope at the tug end. This is rare but there is a standard procedure.

If the cable will not release at the glider end after repeated pulling, the glider is flown out to the left side of the tug. This requires coordination of the ailerons and rudder and is not difficult to master. If possible, let the tug pilot know your intentions over the radio before moving out of position.

The sideways pull on the tug will alert the tug pilot to what is happening and he'll give you a wave of his hand to acknowledge your situation. Of course it is worth continuing to try to release when the glider is off to the side of the tug in case this frees the rope.

When you see the tug pilot's wave, take the glider back into station behind the tug and then climb through the tug's slipstream into high tow. This will make sure that when the tug releases the rope, it will not fall back over the glider and risk breaking the canopy or wrapping around a wing. When the glider is in position, the tug releases the tow rope.

The aerotow rope is not long, but you should plan your circuit carefully to avoid the risk of the cable being snagged on something as you approach low on the strip. This procedure will be fully practiced before you go solo and it's a good exercise in coordinated flying.

There's another even rarer possibility… what to do if the cable will not release at either end. In this instance, the tug pilot will be aware of the situation because you'll already have flown out to the left.

The tug will slowly descend under power and make its way back to the circuit. Your job is to keep the glider in station behind the tug and you will find that with the airbrakes open a crack, you'll be able to keep in station with the rope taut.

When the tug and glider combination rounds out over the strip, the glider lands first and the tug second. The tug will allow the glider to control the landing roll. You brake the glider and the tug keeps enough power on to avoid being overrun by the glider.

This procedure is not normally done pre-solo but once again it is a useful exercise as a confidence builder.

Opening the airbrakes when climbing under tow is not normally needed but if you are flying in level or descending flight behind a tug, such as on a delivery or after a retrieve from an outlanding, you should be prepared to ease the airbrakes open a small amount if the glider looks like overtaking the tug or the rope gets slack.

Your glider is infinitely more slippery than any tug and as soon as you level out from a climb the glider may speed up and the rope get slack. So be prepared to gently pull on the brakes if required.

If you have a radio, make use of it. Talk to the tuggie and explain the problem. Remember that with a failure to release from aerotow you should have plenty of time to sort out the solution.

Landing Problems

Let's state right away that landings do cause problems at some stage to pilots of all skill levels and there's little as satisfying as seeing the local ace bounce a few times down the strip.

Landings need practice and thought to get consistently right and we should not be afraid of doing some circuits with an instructor to fix a problem rather than landing down the far end of the strip hoping nobody can see you.

There are a few common problems with landings. Perhaps the most common is getting fixated by the ground in front of the glider when rounding out, rather than raising our eyes to look at the horizon.

Rounding-out too early

If you round out too early, the glider loses energy (speed and height) too soon. Ideally, you arrive at table top height with enough reserve of speed to give you time to get the glider settling to chair height.

Once the glider is at chair height, it's very difficult to make a bad touch down. If you are rounding out too early, then stop the backwards movement of the stick for a moment to slow the round-out.

While it is important to glance at the ASI and check your speed when you are high on finals, by the time you are at something like twice roof height, you don't need to do this, and you should use all your concentration on getting your touch-down right.

Rounding-out too late

This can be more of a problem especially if it is combined with ground fixation because you run the risk of whacking the glider into the ground or doing a decent sized bounce.

Normally the instructor will take over if they think this is likely so you won't see the consequences but post-solo, you certainly can.

The amount of stick movement required to round out varies from type to type and it is safer to err on the side of an early round-out than a late round-out and risk a hard landing which might damage the glider and in bad cases, the occupants as well.

Rounding out too much

If you continue to raise the nose when rounding-out so far that the glider starts climbing again, you're doing what's called ballooning. The glider will slow down and lose energy, making getting back close to the ground and landing more difficult.

If you find that you are ballooning excessively, close the airbrakes to retain what energy you have and carefully fly the glider back to chair height. Be careful about lowering the nose too much. You won't have time to gain speed and you risk a hard landing.

Rounding out with not enough energy

If you are doing harder than normal landings, it may be because the sink rate is too high as you round out. This may be because you've got too much airbrake pulled or the wrong flap setting on a flapped glider. If the glider drops to the ground as soon as you round out, so long as there's a lot of runway ahead, try reducing the amount of airbrakes a small amount in the last part of finals.

Some flapped gliders have a tendency to settle hard when just after round-out. In this case, using a less positive flap setting might work better, but remember that you must use the same flap setting throughout the landing approach and dumping flaps on finals will cause the glider to sink until it has reestablished enough lift.

Continuous movement of the stick.

After rounding out, you may automatically continue to pull back on the stick. Normally there's slowing of the rate of pull-back or a brief pause. When you are totally comfortable with flying a glider, you don't think about stick and rudder movements. You position the glider where you want without thinking about the control movements required to put it there. When you are learning to fly, you'll probably spend more time thinking about the actual control movements needed to do something.

Fiddling with the controls.

There's a great temptation to use too much control, of both stick and airbrakes when close to the ground and landing. Excessive movements of the stick and airbrakes can result in making ballooning and bouncing worse, not better. Try and leave the airbrakes at a fixed setting and make gently but decisive moves with the stick. Making a concentrated effort to relax and do less can make a big difference to the way you fly takeoffs and landings.

When you're training, you may find that your instructor, with a terse "my aircraft" takes over from you when the glider is just about to touch down. This isn't because you are flying any worse than normal so try not to take it personally. It's just that being so close to the ground, mistakes are more critical and you may not even realise that you are making an error until the two of you talk about it afterwards.

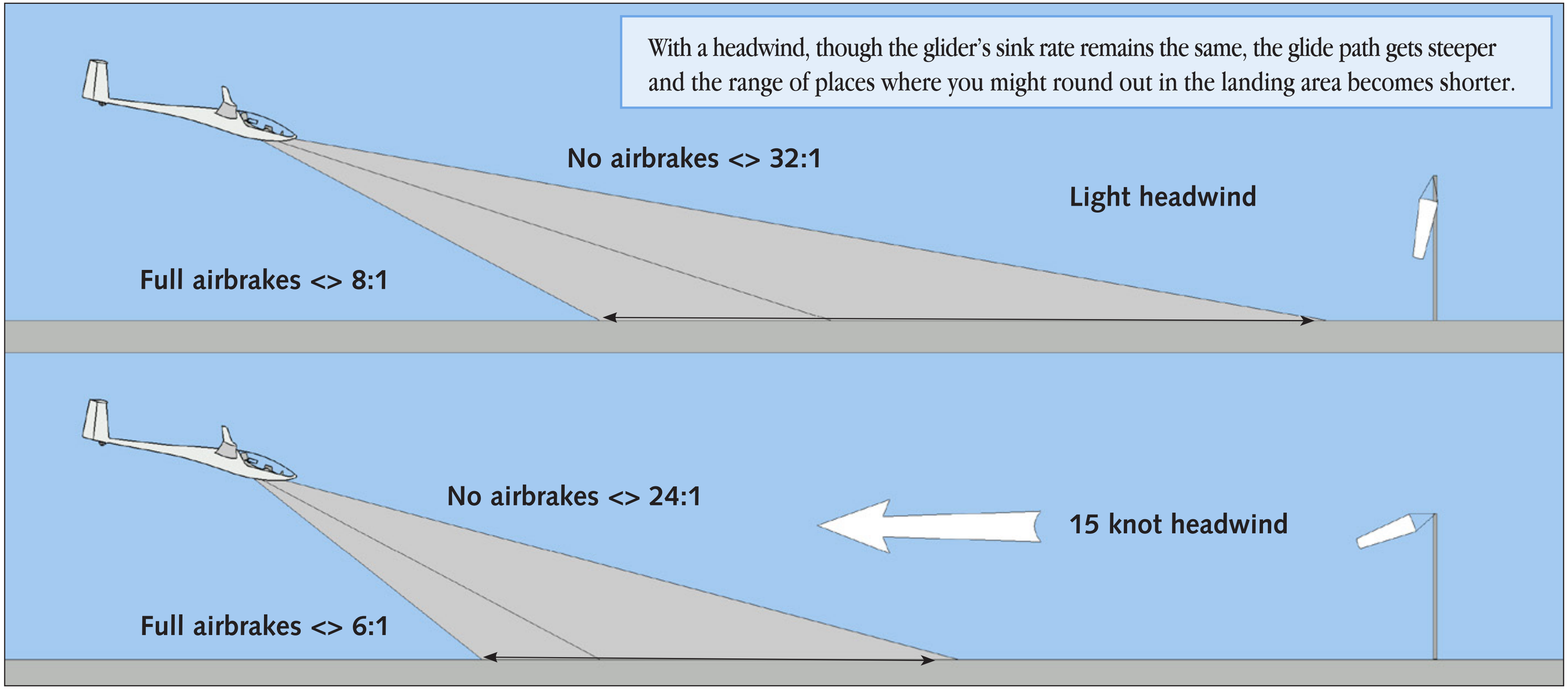
Most of the abnormal situations met when landing are not really emergencies. They may become emergencies unless you take action, but in most cases they are just routine variations on landings.

What to do if the wind is strong

If you know the wind is stronger than normal you should plan your circuit based around this knowledge. There are a lot of ways that you can estimate the wind strength from the speed of cloud shadows to the appearance of dams and lakes, smoke or the angle of a windsock.

When flying the circuit, add half the wind speed to your safe speed near the ground so if the wind looks like 20 knots, then a safe circuit speed of 55 knots will become 65 knots.

Be aware that you will be travelling faster over the ground on the downwind leg and it won't take so much time as normal so get your radio calls and pre-landing checks done early.



In windy conditions, you will probably want to turn onto diagonal or base sooner than normal because the wind will continue to drift you away from the strip on base.

When you turn onto finals, the glider's speed over the ground will appear to be slower than normal, but don't be fooled by this. Continue to glance at the ASI until you are about to round out.

On finals, don't ever be tempted to raise the nose and slow the glider down to try and extend your glide. It won't happen. If anything, a slight increase in speed will get you closer to the strip because you will spend less time in the headwind.

Anticipate that the landing and ground roll will be shorter than normal. If the wind is strong on the ground, remain with the glider until help comes.

Handling cross wind conditions.

If you are able to pick your circuit direction, make your downwind leg on the downwind side of the strip. That is, make your down wind leg on the side where the wind will blow you away from the strip. The reason for this is that you will fly the downwind leg slightly crabbed into the wind and it will be easier to keep the strip and your aiming point in view. Turn onto base early and be prepared for the headwind on base which will extend the time taken for the base leg.

If the regulations make you fly on the upwind side of the strip, you may find it more difficult to keep the strip in view on the downwind and base legs of the circuit. The base leg will be proportionally shorter and which increases the work load.

When the wind is really strong and the width of the strip and local regulations allow, it can pay to offset your final leg so that you are landing into wind, diagonally across the strip. Because of the wind, the ground roll is going to be much shorter and the fact that you're landing somewhat diagonally should not matter.

Visual fixation

Be very aware of getting fixated on something while landing. The most obvious is what one might call "Piano Key Fixation." In the long run, it's important to learn to actually land at a chosen spot but the spot does not have to be right at the start of the strip or on the piano keys of a bitumen strip.

Unless you are landing in a short field, the chances are that an undershoot on landing is going to be far worse than an overshoot. Very very few pilots run out of room when landing compared with those who undershoot and don't make the strip at all. So why not pick a safe spot a little further along the runway?

Another aspect of visual fixation can take over after landing as well as in the air. It's where you are so concerned about not running into an obstacle, you fixate on the thing and run smack into it.

If you think there's a risk of colliding with something on your ground run such as another glider or a fence post, don't keep staring at it, look at where you want to go, look at the gap! Obviously, keep glancing at the obstruction but make sure you don't get fixated on it.

Convenient but dangerous

Don't get fixated on the idea of landing somewhere convenient, such as close to your car or close to other gliders when there are safer but perhaps less convenient alternatives. Always take the safest and least stressful option rather than the most convenient.

Landing Emergencies

Modified circuits.

Routine variations on circuits are called modified circuits and you should have planned and visualised one or more options during any takeoff or landing in case conditions demand it.

Typically, these will include landing straight ahead, making a small turn or only when you have enough height, doing a hockey-stick or J shaped turn to land back on the strip. If you have more height, then fly a modified circuit to land into wind.

It's no secret that low altitude 180° turns after failed takeoffs are very dangerous and any straight ahead option is best.

Many pilots talk through these options on take-off, mentally ticking each option off as height is gained.

Where a pilot reduces the length of their circuit legs and lands somewhere unconventional on a strip, they're not breaking any laws.

Obviously, your options for dealing with launch emergencies may regularly include modified circuits, but this is not the same thing as flying a circuit incorrectly because you ran out of height. A good airman does not make a habit of running out of height in the circuit.

Running out of height

Running out of height is something you need to always plan for when landing and precisely what you do depends on the exact circumstances, but always select a new landing spot somewhere on the strip early. It doesn't matter where, as long as it is safe.

You may get a lot of sink or a sudden wind change which makes the circuit you planned look doubtful. If you start an average circuit at 800 - 1,000' AGL, most gliders are going to take at least 6 to 8 minutes before touching down. However, 600' a minute sink is common and you can get more sink than this, even near the ground on some days.

If there's turbulence around, keep your modified circuit in mind throughout the circuit. You must never get too low on base or final approach so you need to plan early and put this into action as soon as possible. If you make sure that your normal landings are done with half airbrakes, then you'll always have some energy and therefore height to spare on finals.

But what if you do run out of height? The most important consideration is safety. Don't endanger yourself or people in other aircraft or on the ground.

The biggest risk of making a circuit or a landing which is something out of the ordinary is that you won't be seen because people are not looking in that direction. Gliders are very difficult to see at the best of times and if your downwind leg is against the normal direction, it makes this hazard much worse.

Secondly, don't get low in an area you cannot fly out of. If you think a proper circuit is unlikely, then make the decision to modify your circuit as early possible to give you plenty of time to make alternative plans.

Never use the radio if you are really low or running out of time… remember, Aviate, Navigate, Communicate…. but if nothing is stopping you flying safely, a quick call to alert other traffic is a good idea, in the form "Traffic Forbes, glider Alpha Bravo Charlie, making short downwind on 12." or "Traffic Forbes, glider Alpha Bravo Charlie, straight in landing on 12… landing short."

If you give other gliders a clear indication of *where* to look for you, it gives them a much better chance of modifying their plans and not getting in your way.

If you are having to make a circuit against other traffic, if possible, fly as far outside the normal circuit as it is safe to do. Watch out for tugs on descent who may also be using this circuit to keep clear of glider traffic.

If you can't manage even a shortened downwind leg, you may have to join directly on base or even do a straight-in final approach. If this is the case, don't hesitate, but understand that you are the one doing something unusual and it's up to you to keep clear, keep a sharper lookout and if possible, keep others informed.

If you see a glider making a normal circuit while you are making a modified circuit try and make a radio call to alert them. A short call like "X-ray Yankee Zulu, Alpha Bravo Charlie, have you visual 200' above me. I am landing right grass short." This will let them know that even if they cannot see, that you have seen them.

When you are on final approach after a modified circuit, watch out for people moving across the strip, gliders being retrieved and all sorts of other goings-on. They're probably not looking for a glider coming in on your track and probably have not heard any radio calls.

Modified circuits are part of flying gliders and you should not be nervous about making one. In fact you should be quite comfortable with the idea and practice them. If the strip you fly on regularly is long, then set an aiming point further down the strip and pretend that it is shorter than it really is. This is not to suggest that low circuits should be done as a matter of course, but it's important to practice to make sure a pilot doesn't go to pieces when required to modify a planned circuit for any reason.

B Certificate training covers modified circuits in some detail including flying circuits with the instruments covered over.

Remember, safety first! Don't get too low in the wrong place. Keep an active lookout for other aircraft, and always maintain a safe airspeed near the ground.

Ground loops.

A ground loop can happen when the tail of a glider gets out of line behind the main wheel at speed perhaps where a wingtip touches the ground or in a downwind landing. The tail of the glider whips around very suddenly which may result in a broken fuselage boom. Gliders which rest on their tail wheel/skid are more prone to a ground loop than ones which rest on their nose wheel.

There are times when an intentional ground loop is the best option. If you are landing out in a very small field or have badly misjudged a landing and the glider is running at moderate speed towards an obstacle like a person, a fence or building, then ground looping the glider may be the sensible thing to do.

Ground looping is not something which should ever be practised but it can be mentally rehearsed. The essentials are to get a wing firmly on the ground and the tail up or at least less loaded to avoid breaking the tail boom. If the glider is already on its nose wheel, try and get it running on the main wheel only.

You can ground loop to the left or the right but there's a good school of thought which says that you should mentally rehearse looping to the right, just as you would when avoiding any obstacle.

Slow down as much as possible, then push the stick firmly into the front-right quarter and push on the right rudder pedal. This should lower the starboard wing and raise the tail and cause a ground loop to the right providing there's enough energy available. Allow 2-3 wing spans for the manoeuvre and have some good excuses ready.

Circuit Illusions

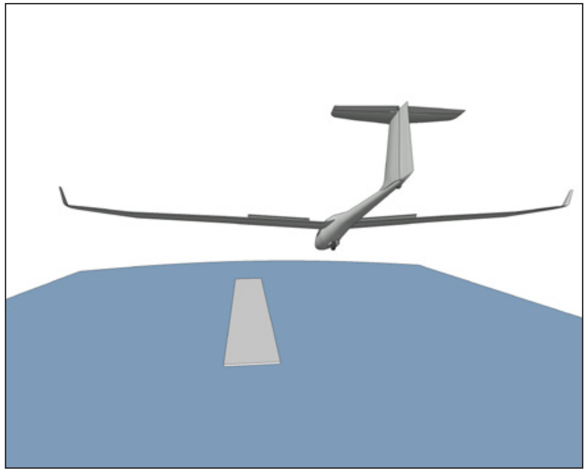
We all get used to flying our own airfield and it is easy to get thrown when landing at an unfamiliar strip.

Flying into smaller fields than you are used to can catch you out. Your mental picture will probably be of the big strip that you're used to and will enlarge your mental picture.

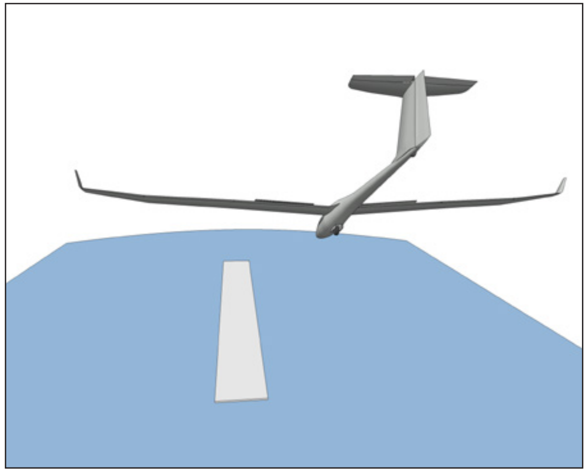
This enlargement factor on small strips will tend to make you join downwind and base closer in than normal and cramp the circuit. If you concentrate on your eyeline angle to the strip rather than the strip itself, you should be able to correct the scale factor and relax your circuit. The animals on the strip which you thought were roos may turn out to be rabbits.

One of the most tricky things to assess is the slope on a runway. From the height at which you start your circuit, the runway probably looks quite flat.

Only after rolling to a stop after bouncing further than the Wright Brothers' first flight (more than once), do you realise that your final approach was on an uphill part of the strip, you rounded out on the top and then tried to touch down on the downhill part of the strip which was sloping away almost as steeply as your glide angle.



On finals onto an uphill strip, you will think you are higher than you are because that's the illusion the picture presents to your brain. An uphill strip will appear to be longer which is similar to the picture you get when you're higher above the strip.



Our brain is excellent at picking patterns but the patterns themselves may be an illusion. If you are approaching a strip which slopes uphill or downhill, the slope will increase or decrease the apparent taper on the runway… and it's this taper which gives your brain the greatest clue as to your height above the strip.

If you are flying in the mountains and you are used to flying in the flatlands, the lack of a clear horizon may at first throw you in turns as well as in the circuit. You should be aware that your eyes may not tell the full story and take extra care to look out for illusions at new or strange circuits.

The CASA publication ERSA (En-Route Supplement Australia) has details about runway elevation, direction, surface and slope and it is essential reading if you are flying away from your home strip. Phone and tablet apps such as Ozrunways have the full ERSA list of runways and are a lot easier to carry in a small cockpit.

Low altitude turns

If the wind is strong, you may be making a turn onto final approach closer into the strip and lower down than normal. There are two catches to think about here, wind gradient or wind shear and the illusion of upwind and downwind turns.

When the wind is strong, always expect wind gradient on finals and when landing. Low down, wind gradient can be caused by the terrain slowing the wind or changing its angle. If you're flying into a strong wind gradient, the wind speed may decrease rapidly as you approach the ground and so will your airspeed. The answer is to set and maintain a safe approach speed.

When banking in wind gradient, gliders have to take special care because the large wingspan can mean different wind speeds between the high and low wings.

Unlike hang glider and paraglider pilots, sailplane pilots don't spend a lot of time looking down at the ground at low altitude except when ridge soaring and as a result they may be less aware of the powerful visual illusion when turning in a wind close to terrain.

When the glider turns downwind, the ground appears to slide by very fast which gives the illusion that the glider is flying faster than normal and there may be a strong urge to pull back on the stick. When turning back into the wind, the glider appears to be slowing down.

In fact, unless you have responded to the illusion, the glider is flying in a moving air mass without reference to the ground and the airspeed remain constants.

Be aware that these effects may be present when making low altitude turns and resist the urge to speed up or slow down depending on what the ground appears to be doing. Fly by reference to the glider's attitude to the horizon and the ASI.

Outlanding

If you can land consistently and reliably on an airfield, you can just as confidently use the same techniques if you have to make an outlanding. The principals are largely the same, but you need more time and therefore more height when outlanding to assess your options early, so you don't get rushed.

Be aware that in many cases, your outlanding will be caused by sink conditions and that can shorten your decision time when planning the outlanding.

When you are flying cross country, even though you are well above the ground, you need to continually be on the lookout for suitable outlanding places and never overfly areas where there are no outlanding options.

Getting used to finding paddocks, assessing them at a distance and confirming or rejecting them as possible landing places when you get closer is an essential part of gaining confidence when soaring.

In some regions, there are many airfields, from town strips to ag strips, which can be used as stepping stones though be aware that not all strips in the bush are kept in a condition safe to land on.

If you discover that you're particularly nervous about outlanding, why not organise a flight in a touring motor glider where you can practice assessing outlanding fields from above and then descend and check out the options in detail. In a motor glider you can check out many different paddocks in a short time and it can be a worthwhile confidence building exercise.

In any cross country flight you should have suitable landing spots sighted well before you get down to 2,000' above the ground. Normally there should be more than one option. If this is not the case, you shouldn't have been flying over that terrain in the first place.

Below 2,000' you make a full assessment of the paddocks and preplan circuit options.

By 1,500' have your paddock selected so that by the time you are at normal circuit height, you are ready to join the downwind leg.

Training for outlandings is covered in detail before the C Certificate and your first cross country flights. There's a checklist which you should memorise to help assess suitable paddocks which covers the essential things to look out for called the "6 Swesses".

WSSSSSS

Outlanding Check list

W	Wind	If there is no indication of wind on the ground, use the longest distance along the paddock which may be a diagonal. Assess the wind from drift, dust, smoke, dams or other signs. Land into wind as much as possible.
S	Size	Adequate length for landing, normally 300 metres, corner to corner diagonally if necessary. Choose the largest available rather than the most convenient.
S	Slope	If a slope can be detected from circuit height, it is too steep to land in. Pick another paddock. Land uphill, even if there's a small downwind component.
S	Surface	As smooth as possible. Stubble and dirt are best. Avoid crops like canola.
S	Stock	Avoid paddocks with animals. Sheep are usually not much of a problem. Cows eat or walk on gliders. Single cows aren't cows (Bulls!), Horses may panic.
S	Surroundings	With adequate approach paths. An approach over trees means a longer distance into the field before touchdown and there's a risk of wires hung between trees, wind shadow or turbulence off the trees.
S	SWER	Single Wire Earth Return power lines are very hard to see. Overhead power lines and wires strung between trees as well as fence wires are a fact of life in the country, especially near buildings. It's hard to see wires so look for poles or plant growth along fence lines. Don't fly an approach between trees.

W **Wind and sun**. Assess the best direction to land in. Ideally, you want to land into wind, up a slope and with cross lighting from the sun to give you a chance to see obstacles. It's unlikely you'll get all three of these.

If the sun is low, try to plan your circuit to avoid flying directly into the sun on any leg.

If the wind is anything over 10 knots, there will be turbulence from trees and other obstacles and your drift over the ground in circuit will be significant, so get a good idea of wind speed.

You may see shadows of clouds scudding over the ground while there is almost no wind on the ground. If you have been thermalling low down, you should have a reasonable idea of the wind speed and direction from your drift over the ground.

Throughout each flight and before landing, check for signs of wind on the ground… dust blowing behind trucks and tractors, wind on lakes and dams, smoke from bush fires and which way the cows are standing. Cows stand facing downwind while horses stand facing into the wind.

S1 **Size**. Is the paddock big enough? A 300 metre landing run should be long enough but all things being equal, look for the biggest field in a group. It is always better to land diagonally on a field to maximise the length available for landing.

Never land in a particular area because it is convenient when something safer is available close by. A long walk is preferable to a wrecked glider or injury.

S2 **Slope**. If you can see a slope from above, then the paddock is too steep to land in. There are clues to help assess slope such as shadow and contour banks which always run at right angles to a slope. Use these to evaluate the slope. That being said, it's almost always better to land slightly uphill and downwind than the other way around.

S3 **Surface**. Find somewhere which is as smooth as possible. Obviously shadow is a clue to smoothness, but the visual effect of this will change as the sun angle changes through the day.

Colour is a good indicator because it gives a clue as to what's growing in the field, if anything. Freshly cropped and fallow fields are better than fields which are in crop but low crops are better than high. Fields with deep furrows are to be avoided if possible and if not, land in line with the furrows, not across them.

Local knowledge is a good idea. If you're not a bush dweller, ask a local to describe to you the appearance of common crops in the region and what to avoid, crops like canola and cotton. Examine the appearance of the fields either side of the road as you drive to the strip. Brown fields have often been cultivated and can be a good surface… there's a saying "if it's dirt, you won't get hurt."

S4 **Stock**. Be careful of landing near animals. Sheep are not too much of a problem because they will usually run away. Kangaroos will run, but you have no idea in which direction. Cows regularly eat gliders and don't always get out of your way but can be a good indication of which way the wind is blowing. Fields with horses should always be avoided, especially expensive horses and most especially expensive horses with people on them.

Even a glider which is safely landed in a field will spook a horse which has not seen a glider in that paddock before and that can be dangerous.

Remember that some horses, bizarre as it may seem, are worth far far more than humans and they will hurt themselves (at your expense) faster than you can say “debtor’s prison”.

S5 **Surroundings**. Is the circuit clear of other aircraft? Are there power lines anywhere near? Are there hills or contours in the surrounding area which will confuse your assessment of altitude or even cause turbulence on windy days? If there’s a slope or dam, be aware that there may also be ditches.

Cattle flats alongside river beds, even dried out river beds may have deep holes in them, left by cattle walking on partially dried ground and cracking the surface.

Be alert for fences crossing paddocks which, especially in the case of electric fences may be invisible but for a slight change in the colour of the crop or ground.

S6 **SWER**. There’s a type of wire very common in country areas called a Single Wire Earth Return or SWER… another Kiwi invention.

These single wires are hung off thin poles and run over larger distances than with normal power lines. It’s a low-cost solution used in remote areas for buildings and machinery like pumps. Any structure in the bush is likely to have wiring so look closely at the surroundings.

Single Wire Earth Return and other power lines are some of the biggest dangers when outlanding. Both power lines and fence wires can be very difficult to see and it’s usually easier to look for evidence of a wire support such as the power pole, fence posts or a line of vegetation marking a fence or cast shadows from poles.

If you have touched down and are rolling towards a wire, be prepared to ground loop the glider rather than running into the wire.

You may have gathered that there’s a lot to look out for when outlanding, and they are the factors which make outlandings inherently more risky than landing at an your home airstrip. Nevertheless, hundreds of perfectly safe outlandings happen every year.

Outlandings should be planned for at all times when you are gliding, especially if you are getting low towards the end of a day. You should never leave planning until the last moment.

Make the decision to outland early. If there’s time, make a radio call to alert others that you may be outlanding but don’t let the radio get in the way of safe flying.

Concentrate on flying a normal circuit as you would at your home airstrip. Having landed, keep your ground roll as short as possible by using full airbrakes and as much wheel brake as necessary to stop smoothly without lifting the tail.

A word about wires

They’re everywhere! If you are ridge soaring or flying down valleys, be aware that high voltage power lines may run down from the top of the ridge in long, unsupported and hard-to-see catenaries which can be suspended a long way out from the terrain. If the high ground is timbered, you can often see a cleared path dotted with poles or towers but when the wires go over the edge, the cleared ground may stop, making the wires close to invisible.

Many lucky pilots have only realised that the wires were there when they flew under them and saw the wires silhouetted against the sky Of course the same caution applies to cable cars but we have few of these in Australia.

Self-Test Questions

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

1. Which wingtip is held when pushing or towing a glider?
2. What is the minimum rope length for towing a glider with a car?
3. Is the trailing edge of the wing a suitable place to push a glider?
4. Who is entitled to give a "Stop" signal at the launch point?
5. What clearance is required by the pilot before take-off?
6. What is meant by the "working speed band" on a winch/auto launch?
7. What is the primary reference for establishing the correct towing position on aerotow?
8. What should be the trim position during an aerotow?
9. Name the sequence of events prior to and during release from aerotow.
10. What is the first priority following launch failure?
11. Define the non-manoeuvring area.
12. What action is taken by the pilot if the speed falls to 1.3Vs on a winch or car launch?
13. What action does the glider pilot take if the tug pilot waggles the tug's rudder?
14. What does it mean if the tug pilot rocks the tug's wings from side to side?
15. What is the primary objective of flying a circuit?
16. What is the minimum circuit speed?
17. Define wind gradient. What is its effect on a glider approaching to land?
18. At what point on the approach are the airbrakes used?
19. What action does the pilot take on detecting an undershoot?
20. Define a "stabilised approach".
21. What is the recommended action in the event of the glider "ballooning" on landing?
22. What actions are taken by the pilot if the glider runs out of height in the circuit?
23. What is the final approach speed of a glider which stalls at 34 knots, approaching to land in a 10 knot headwind?
24. What is the minimum height above ground for selection of a specific landing paddock on a cross-country?

AIRWORTHINESS

Glider construction and limitations

Unlike most aircraft, sailplanes are a piece of sporting equipment and they need to be constructed in materials which can handle the varied conditions of sport aviation. Gliders need to be made light, strong and easy to maintain.

Over the years, gliders have been made from a variety of materials but in many respects we are now living in a golden age for glider construction. Modern materials have not only given us very efficient gliders, but ones which are very strong and very simple to maintain.

Almost all modern gliders are made from composite materials, either glass fibre or carbon fibre bonded with epoxy resin. The incredible strength of carbon fibre means that less of it needs to be used compared with glass fibre so the weight of a glider can be reduced. Apart from performance benefits, a glider with light wings is much easier to rig.

For the sailplane designer, the biggest benefit of composite construction over earlier methods is that it can be moulded to produce a stable, accurate shape. This allows laminar flow aerofoil sections to be used. These give huge increases in performance over traditional turbulent flow sections but require higher levels of accuracy in construction.

There is no doubt that composite construction is easier to maintain than any previous method of building gliders. Take a quick look around club sailplane hangars and you'll see plenty of glass fibre gliders around 40 years old which are still perfectly airworthy even though at the time they were constructed, their life span was estimated to be less than a third of what it's turned out to be.

Since carbon fibre is being used in increasingly large quantities in transport and military aircraft, sports equipment and wind turbines, carbon fibre is being made in large quantities and the cost is continually falling. This will mean the proportion of carbon fibre used in all gliders is likely to increase over the years.

The traditional methods.

The earliest gliders, like the aircraft of the time, were made from wood and doped fabric. These gliders were strong and light, often nice to fly but hard to maintain. One of the common glues used on wood was made from something like porridge and softened in humid conditions. The fabric needed to be stripped off frequently for inspection of the structure. Hopefully, most wooden gliders using dodgy glue have been retired, or better, rebuilt using modern glue.

Although it is possible, as in boat construction, to laminate wood into complex curves, wood is not very stable and when used for laminar flow wings, the maintenance burden is very high.

In countries where metal aircraft construction is well understood, gliders have been manufactured from aluminium or fabric covered steel tubing (frequently with wooden wings). Again, metal constructed gliders are strong and light but difficult to maintain. It is also very difficult to build laminar flow wings from traditional aluminium construction.

There are still metal gliders in common use but their numbers are declining for two reasons.

- Most were designed with limited service lives compared with composite gliders.
- The maintenance burden on metal gliders is very high. Typically, a metal glider in a busy club will take four times as many hours to keep in the air as a middle aged glass fibre glider.

With composite construction, we have a material which ticks all the boxes and with some gliders having spans over 32 metres, there's little the sailplane designer or owner could complain about.

Design loads and limitations of Gliders

Construction techniques may change, and we'll almost certainly see increasing use of vacuum bagged pre-impregnated fibres (pre-preg) and resin infusion instead of wet layup, but it's likely that carbon fibre composite construction will be the material of choice for gliders for the foreseeable future.

Moulded gliders made from modern composites are slippery, low-drag aircraft. Unlike older wood, metal and fabric gliders, they fly fast and accelerate very fast. With an older glider, you can trim for circuit speed with a large degree of confidence that the glider will stay at that speed through bumps and updrafts.

With a modern low-drag glider, it's nowhere near as easy because the glider can accelerate so fast if disturbed. With modern gliders we have more modern training methods but you the pilot should be always aware that with high speeds come high loads, especially high control loads and thoughtless use of the controls can quite quickly and easily damage a glider.

In the early days of flight, little was known or understood about the loads on an aircraft in flight and how to make an aircraft stable yet manoeuvrable.

The first world war saw a massive increase in the science of aeronautics, though the first post-war glider builders may have not been aware of much of it. There were many accidents and deaths in the early 1920s resulting from gliders breaking up when they were sucked up into clouds.

Within a very few years, designers were properly stressing their gliders for the flight conditions met while flying. Structural failures are now a thing of the very distant past… provided the aircraft is flown within its intended flight envelope.

The flight envelope for an aircraft is a loose term to cover the range of limits within which the aircraft can be safely flown by a pilot of average ability. Most modern sailplanes are designed, just like transport aircraft to a strict international airworthiness standard.

The current Certification Standard for sailplanes is CS-22 which supersedes the previous JAR-22. Manufacturers must certify their sailplanes to comply with this standard.

CS-22 contains a lot of very sensible safety requirements such as: When stalled during a co-ordinated 45° banked turn, it must be possible to regain normal level flight without encountering uncontrollable rolling or spinning tendencies.

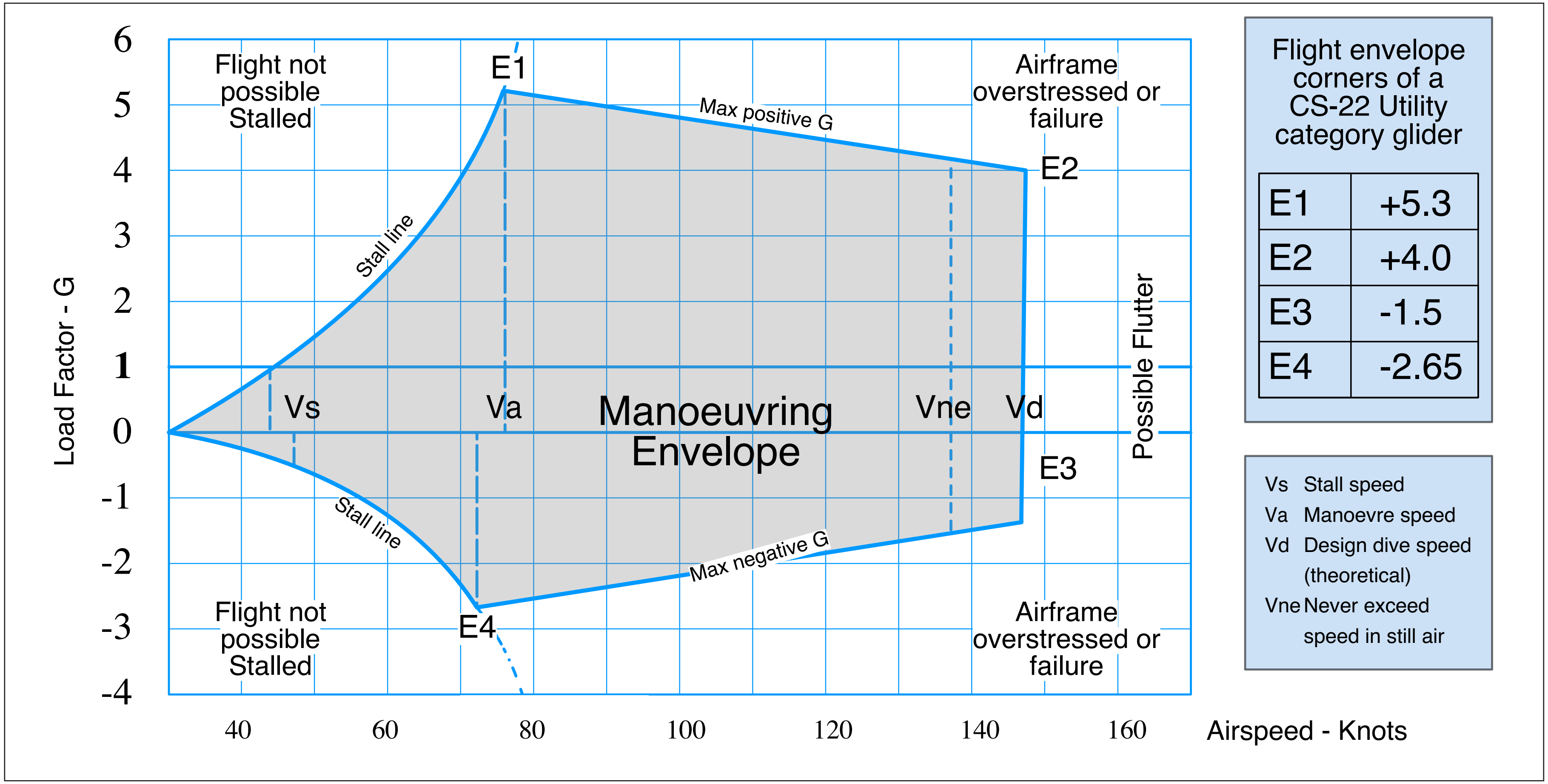
And: There must be a clear and distinctive stall warning with air brakes, wing-flaps and landing gear in any normal position, both in straight and in turning flight.

CS-22 does assume that the pilot has a light touch on the controls and flies sensibly. When reading the following about the flight envelope, try to remember that and while you're flying, develop a feeling for the glider and treat the controls with respect.

A glider's flight envelope will also include other factors such as the performance under airbrakes, flaps or on tow. The essential limits of the flight envelope for a particular glider are always written on a placard in each glider's cockpit.

It's important that you read the placard of each glider that you fly and commit the important figures to memory, especially figures like maximum winch and aerotow speeds.

The manoeuvring envelope



The manoeuvring envelope under CS-22 defines the maximum loads the glider can withstand and their associated speeds. It is represented by a graph with airspeed on the horizontal axis and wing loading or 'G' on the vertical axis. The central shaded area of the graph shows the area inside which the aircraft is safe to fly.

The left edge of the shaded area is called the stall line… anything more left than this on the graph means the glider is stalled and will not fly. The outside of the shaded area defines the no-go zones. Either the glider will not fly under these conditions, or damage or structural failure can result.

The manoeuvring envelope graph is 2D and only shows loads caused by the elevator in pitch. This is quite important. What it means is that if more than one control is used at a time (pitch and roll for example) that the envelope boundaries can be exceeded.

If you try to pull out of a high G spiral dive and use the elevator and ailerons at the same time, you could exceed the maximum G loading of the airframe.

In terms of G loading, gliders come in two flavours, Utility and Aerobatic. Most gliders fall into the Utility category. This means that they are designed to take loads of +5.3 G and -2.65 G without sustaining structural damage.

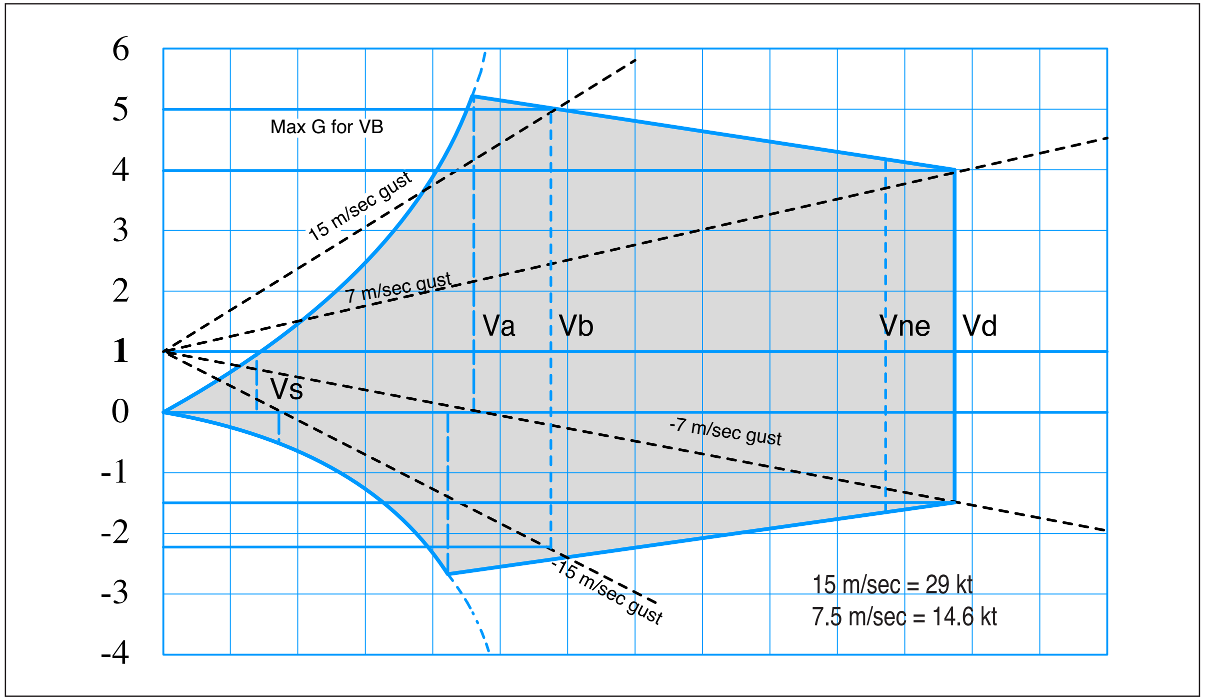
The right-most side of the shaded area is the glider's design Dive Speed (Vd). Dive Speed is a more or less theoretical limit and is not marked on the placard, but Vne (Never Exceed Speed) is. Vne is 90% of Vd. If you never exceed Vne then you won't need to know what happens if you exceed Vd.

The upper and lower edges of the shaded area are the limit loads in positive and negative G. These values have evolved through experience as being suitable for sailplanes. CS-22 requires that a glider can withstand a load factor of at least +5.3 G and -2.65 G.

The maximum manoeuvring speed Va is where the 5.3 load limit line meets the stall line which is shown as E1 on the graph.

Up to this speed, the pilot can apply maximum deflection of any one control. Remember that… *any one control*. Which means that excessive coordinated control movements at speeds well below Va can cause damage.

The faster a glider flies, the more the load on the controls for any given deflection. This is called Control Force Gradient. To some extent, the fact that the controls feel stiff and heavy at high speeds is a good thing because it means you have to be properly ham-fisted to overload the airframe.



How rough is rough air? Well, it's more than the normal bumps you get in thermal flying. If you are regularly leaving the seat and being pushed against your seat belt, then slow down. As long as you are not flying fast, you will not damage the glider.

Typically the roughest air we're likely to fly in is when wave flying in lee rotors but it can be in other places found in thermal flying. There can be violent up and down movements of air near storm clouds.

If you fly close to a storm downburst and are sucked up towards the spreading cloud overhead, you may have to fly very fast to escape, close to Vne and through up and down 'gusts' which may be close enough to the 7.5 weak gust strength that you risk damaging the airframe.

The Gust Envelope

The manoeuvring envelope happily assumes that the air is smooth. As we know, the air we fly in is often far from smooth.

Another set of lines is superimposed on the manoeuvring envelope graph which is called the gust envelope. These define the limiting speeds and loads in rough air and the maximum rough air manoeuvring speed.

The maximum designs speed in rough air is called Vb.

CS-22 states that at Vb, the design rough air speed VD, the sailplane must be capable of withstanding positive (up) and negative (down) gusts of 15 m/s acting normal to the flight path.

And: at the design maximum speed Vd, the sailplane must be capable of withstanding positive (up) and negative (down) gusts of 7·5 m/s acting normal to the flight path.

Limitations Placard.

There must be a placard in the cockpit which notes a number of maximum speeds. These include:

- Maximum speed (Vne)
- Maximum manoeuvring speed rough air (Vb)
- Maximum winch launching speed
- Maximum aerotow launching speed
- Maximum manoeuvring speed smooth air (Va)

MAX. PERMITTED A.U.WEIGHT (MASS): 1543 lb / 700 kg			
MAXIMUM PERMITTED SPEEDS (IAS) :	**km/h**	**kt**	**mph**
Never exceed speed	**250**	**135**	**155**
Rough air speed	**180**	**97**	**112**
Maneuvering speed	**180**	**97**	**112**
Aerotowing speed	**180**	**97**	**112**
Winch launching speed	**150**	**81**	**93**
Landing gear operating speed	**180**	**97**	**112**
For power plant extension/retraction	**110**	**59**	**68**
With ignition **ON**	**125**	**67**	**78**
Power plant extended speed	**160**	**86**	**99**
PERMISSIBLE MINIMUM SPEED (IAS):			
For power plant extension/retraction	**90**	**49**	**56**

Max. permitted speed				
Altitude		V_{NE}(IAS)		
[m]	[ft]	km/h	kt	mph
0	0	**250**	**135**	**155**
1000	3281	**250**	**135**	**155**
2000	6562	**250**	**135**	**155**
3000	9843	**241**	**130**	**150**
4000	13123	**229**	**124**	**142**
5000	16404	**217**	**117**	**135**
6000	19685	**205**	**111**	**127**
7000	22966	**194**	**105**	**121**
8000	26247	**183**	**99**	**114**
9000	29528	**172**	**93**	**107**
10000	32808	**162**	**87**	**101**

It may also include:

- Maximum landing gear operating speed
- Maximum flap extending speed
- Maximum take-off mass
- Maximum powerplant extension speed
- Indicated and True Airspeed (IAS & TAS)

The placard shown here is for a popular high performance two seat glider available with an optional sustainer. You'll note that possibly for convenience, apart from Vne, the other critical speeds you need to memorise for this glider after launching are all the same… 97 knots.

Ideally, this placard is visible in flight but in the cramped cockpit of a modern single-seater, this is rarely the case.

Important placard information such as the maximum permitted speeds at altitude should be duplicated on a smaller placard beside the ASI and it's a good idea to have a copy of the main limitations placard as well as other information such as flap settings and water ballast on a laminated sheet put in an accessible place in the cockpit.

Flutter

Before looking at the meaning of Indicated and True Airspeed, let's look at flutter. The word conjures up the movement of a bird or butterflies wings and you may be tempted to think "if I get a bit of flutter, I'll just back off and slow down a bit."

Well, flutter on a glider can be *exactly* like flutter on a bird's wings, except a glider's wings are 15 metres or more in span. When a glider gets into a flutter condition, the wingtips may move up and down *a metre or more, several times a second.*

There are video clips on the internet of a glider which was deliberately modified to flutter. A short look at this should have you taking flutter very seriously! Flutter can rapidly and completely destroy an airframe and is an experience you must avoid.

Flutter can occur at speeds lower than Vne. The cause of this flutter may be faulty balancing of the control surfaces, missing mass balances, wear or excessive control system free-play or flying the glider outside its placarded limitations.

The wings of a glider have a natural frequency at which they tend to flex. In normal flight, this flexing is well damped but conditions like flutter in a control surface can negate the damping and cause the wings to flutter at speeds below Vne.

Factors like control circuit wear, sudden control movements and poor maintenance on things like aileron gap seals can trigger flutter at lower speeds.

When flutter occurs in some part of a glider, the part may flex beyond its aeroelastic limit and even though no damage may be visible, it will be damaged.

Where control surfaces flutter, the movement may be smaller and the vibration much faster… to the point where the aeroelastic limit of the control surface is exceeded in a few seconds.

The important thing to understand here is that flutter is related to inertia and inertia is a function of true airspeed and not indicated airspeed. This means you must be cautious when flying close to Vne, especially at altitude. The top right corner of a glider's flight envelope can be an exciting place and one that only test pilots should explore!

You should be aware of the True Air Speed as you fly higher to make sure that you don't risk getting into flutter conditions.

If flutter occurs, slow down smoothly and land immediately. Make sure the aircraft is grounded and report the problem.

The Air Speed Indicator (ASI)

The airspeed indicator on a glider shows the speed of the glider relative to the air around it. It works by measuring the difference between the dynamic air pressure caused by the glider's speed at the forward facing pitot tube and the static or atmospheric pressure from ports on the sides of the glider's fuselage.

Essentially, the ASI is measuring the number molecules of air per cubic mm coming in through the pitot tube compared with the static tubes on the fuselage sides.

Vne is based on the TAS or True Air Speed, not the Indicated Air Speed (IAS) as shown on the ASI and flutter is closely related to Vne.

As a glider flies higher, air density decreases… there are less molecules per cubic mm. Because the glider weighs the same as it did down low, it will have to fly faster through the air so the same number of molecules of air strike the wing and the same amount of lift is generated.

Because the ASI is measuring the density of molecules, the indicated speed IAS remains the same, however the true air speed TAS is higher This difference between IAS and TAS gets greater with altitude.

Altitude in [m]	0-3000	4000	5000	6000	7000	8000
V_{NE} IAS km/h	270	256	243	230	217	205
Altitude in [ft]	0-10000	13000	16000	20000	23000	26000
V_{NE} IAS kts.	146	138	131	124	117	111

An aircraft's aerofoils and control systems respond to dynamic pressure caused by speed through the air (in other words the density of the air molecules), and a glider will handle in the same way at altitude as it does closer to the ground and for example, will stall at the same *indicated* air speed on the ASI… though the true air speed may be quite different.

If the glider is fitted with a glide computer, the indicated GPS speed may be closer to TAS but since GPS speed is measuring speed over the ground and is affected by the prevailing wind speed, GPS speed cannot be relied on as an indicator of TAS.

Flutter is dependent on a number of factors such as the inertia of the wing and control surfaces and the speed of the air over the wings. Not air density.

Therefore when you fly high, to avoid exceeding Vne, you must correct for the error in the indicated air speed to work out the true air speed. This is especially true when wave flying where the difference between TAS and IAS can be large. Practically, you need to reduce the glider's Vne speed by 1.5% for every 1000' above sea level.

A placard similar to the one shown above, detailing Vne at altitude is put close to the ASI as a reminder.

Two other things should be taken into account when flying high:

Rough air can be met during wave-flying, so slow down if you meet clear air turbulence.

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 instability when flown at high altitude. This will be most noticeable when flying at a high TAS.

Weight and balance

Anyone who has built and flown a model aircraft knows how important it is to get the centre of gravity correct. It's far more important with full sized gliders. There are several ways in which the weight and balance of a glider can change on a daily basis; crew weight, cockpit baggage, water ballast and any fuel load. These are lumped together under the heading of weight and balance and they are an essential part of the flight envelope calculations.

The main variable for training gliders is cockpit load which is made up of crew weight and any baggage. In most cases, baggage is stowed at the back of the cockpit, almost over the wing spars and therefore close to the centre of gravity. This means in most cases that it's the crew weight that is the largest variable in weight and balance.

In most gliders, the crew sit forward of the CofG but in some touring motor gliders the crew is aft of the main spar.

With self launchers and motor gliders, the picture may be quite different. The weight of fuel and position of fuel tanks in the aircraft may be critical to the CofG position, especially if a lot of fuel is used in flight.

As the centre of gravity moves aft, the glider becomes more sensitive to control inputs. If the centre of gravity is aft of its design limit, the glider will be very sensitive to control inputs and may be unstable, spin easily and may not recover quickly from a spin. The glider may even be stable in a spin and not recover at all.

With too high a cockpit load, the centre of gravity will be too far forward. The elevator will be operating outside its design limits and may be overloaded. The pilot may have inadequate elevator movement to flare on landing, to recover from a dive and may in any case over stress the tailplane.

For these reasons, it's essential to think about weight and balance carefully, especially with unfamiliar aircraft or a change of crew. Ballast can be added in the cockpit to compensate for light pilots to bring the cockpit load above the minimum and bring the CofG forward of its aft limit but the maximum permitted cockpit load must never be exceeded.

Part of the pre-flight checks, especially on a type that you are not familiar with, is to look at and understand the weight and balance limits on the cockpit placard and you should never fly a glider outside these limits.

Definitions of weight and balance.

- **Empty weight -** The glider's empty weight, equipped to fly, without pilot, parachute or removable ballast.
- **Maximum mass** (weight) or **Maximum take-off-weight -** The maximum flying weight
- **Maximum pilot weight** - The heaviest pilot with parachute that can be accommodated without exceeding maximum take-off-weight or moving the CofG 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. Removable ballast may also take the form of a water tank or weights fitted in the tail fin.
- **CofG range -** The range of movement of the centre of gravity, shown in terms of a maximum and minimum pilot weight. In the case of two-seaters, a dual scale is often used in order to take into account the varying weights in each cockpit.

Loading chart

Cockpit load (parachute included)

maximum	110 kg	242 lbs
minimum with fin battery (2,6kg)	92 kg	203 lbs
minimum without fin battery	78 kg	172 lbs

With lower pilot weight necessary ballast must be added

In the aircraft's Type Certificate Data Sheet and flight manual, the CofG limits will also be shown in millimetres forward or aft of a datum point. These are used for annual weight and balance checks rather than for daily use.

When flying with water ballast, the weight and balance must also be checked. In most gliders, water ballast is carried in bags or tanks which are forward of the main spar. This means that the CofG moves forwards with increasing ballast.

If noted in the flight manual, this may be corrected with a separate water tank in the fin of the glider. It's important to drain the fin tank before or at the same time as the main ballast in the wing tanks.

It's quite common for high performance single seaters to be built with quite a high minimum cockpit load so that the pilot who buys the glider has the CofG closer to the aft position. In this case, ballast must always be added when a lighter pilot flies the glider.

Weak links

Gliders can vary enormously in mass . An ultralight sailplane may weigh only 75 kg. A vintage single seater may weigh around 150 kgs, while a fully ballasted high performance single seater may have a take-off weight of over 600 kg and a two seater over 800 kg. This has serious implications when aerotowing or winch launching.

A weak link is inserted into the winch cable or aerotow rope, normally at the glider end, to protect the glider against over-stressing during the launch and obviously, this must be matched to the glider's takeoff weight.

The specified maximum weak link strength is noted on the glider's limitations placard. Weak links are coloured for easy identification. You should make sure the weak link is the correct strength before launching, especially if the glider you are flying is particularly light or heavy.

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 this, the glider must be constructed to an accepted airworthiness code, such as JAR-22. Each 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 C of A is only valid if the glider is being maintained to GFA standards. Major maintenance is carried out at the Annual Inspection (commonly known as the "Form 2" and recorded in the Maintenance Release book which is carried in the cockpit of every aircraft.

Some gliders may not qualify for the issue of a C of A. There are a number of reasons for this, such as modifications to the structure or with new and imported gliders. Such gliders may be issued with an Experimental Certificate or 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

Each glider has a Maintenance Release book or Form 1 certificate, normally kept in a pocket in the glider's cockpit. It's a legal document and should be looked after. Apart from anything else, you cannot legally fly without a valid Maintenance Release in the glider on every flight.

The Maintenance Release is checked each day before a flight during the daily inspection. The book contains information such as number of landings, total hours, notes on major and minor defects and on regular maintenance. A good look at the Maintenance Release will tell you a lot about a glider and where to look for possible problems during a daily inspection.

The Maintenance Release or Form 1 certifies that the glider is being maintained in accordance with GFA requirements and validates the C of A, Experimental Certificate or Permit to Fly of the glider. The Maintenance Release is issued by a GFA-qualified (Form 2) inspector and is renewed on completion of the relevant inspection. Always check the Maintenance Release before flight. No release, no fly!

Daily Inspections

If a Maintenance Release is in the glider and is within its validity period, the glider is legal to fly… but it may not be airworthy to fly. For example, the glider may have suffered a heavy landing the previous day and there may be damage present which the last pilot did not notice or did not enter into the Major Defects section of the Maintenance Release. It is therefore a requirement for gliders to get a Daily Inspection before being allowed to fly each day and the Inspector is responsible for ensuring that the glider is safe to fly.

If the glider is cleared to fly after the daily inspection, the maintenance release is signed by the person who checked the glider. Every pilot flying a glider must check for a signature to show that the Daily Inspection has been carried out before carrying out his own walk-round inspection prior to flight.

Ground handling - Airworthiness implications

The purpose of proper ground handling is to protect the glider from being damaged by collision with obstacles and strong wind. However it is possible to damage gliders by the wrong kind of ground handling and this may not be visible to the person handling the glider and another pilot may end up suffering the consequences.

Never apply large forces in a fore and aft direction at the wingtip. This can easily happen when two people are ground-handling a glider and they both pull on opposite wingtips. Excessive force can also be applied at the wingtip when a glider is turned or pulled close to a tree or hangar and a wingtip strikes. Because of the long wingspan, enormous stresses can be put on the wing-root fittings, stresses which the designer did not intend.

Don't lift a glider by its tailplane. Again, this applies stresses which are not designed for and can lead to unnecessary wear on tailplane fittings.

Don't sit on the leading edges of parked gliders. It is primary structure and, although you can push on a leading edge, they will not take the weight of a person.

If a glider gets bogged in mud and a vehicle is used to pull it out, attach towropes to both tow hooks of the glider to spread the load and avoid local over-stressing of the tow hook installation and only pull in the normal tow direction.

The walk-round inspection

Before starting any pre-takeoff checks (including the daily inspection) you should walk around the glider and have a good general look at it. You're looking for damage and deterioration which may have come from a number of sources.

- Damage sustained in routine operations including takeoffs, landings and tow-outs.
- In-flight over-stress caused by mishandled aerobatics, flying too fast in rough air or the onset of flutter.
- Damage caused by heavy landings, nose-overs due to exuberant braking when landing.
- Damage sustained while the glider is being towed to the launch point.
- Impact with aero-tow or winch gear.
- Flat tyres.

In most cases, damage should have been reported by the previous pilot, but damage isn't always noticed at the time and all pilots should develop a healthy curiosity about the condition of any aircraft which they fly.

The walk-round inspection doesn't need to take very long, a couple of minutes at most. Start at the cockpit, then walk back to the nose and work around the glider in a clockwise or anti-clockwise direction looking for signs of anything wrong. The Maintenance Release contains a diagram and list of possible things to look for.

For a walk-around inspection at the launch point, make sure the obvious things are looked at… the wings are secure, the control surfaces are working in the right sense and have not been damaged by the previous landing and return to the launch point etc. and of course make sure the wing walker and tail dolly are not on the glider.

Heavy landings

After a heavy landing, there may be signs of over-stress where the wings join at the fuselage. These may be visible on the wing structure inside the cockpit as well as outside. In a heavy landing, the wings move forwards and downwards and apply a lot of stress to the wing root area, wing pins and around the wing root spar. If in doubt, the wings should be removed and the wing pin areas closely examined.

There may also be signs of damage to the undercarriage. The tyre may have slipped on the rim or gone flat.

In-flight overstress

Look for signs of excessive 'G' loading from aerobatics, often in the form of cracking around the edges of the airbrake box, span-wise cracks at the leading edge join and chord-wise cracks in the lower surface of the wing. In fact, some of these cracks can be caused by the stresses of “normal” wave flying. If you see anything you don’t understand, ask someone for guidance.

Look for signs of over speeding underneath the tailplane, where there may be some signs of compression failure of the skin due to large downloads on the tailplane from high speed flying or high speed pull-ups. Over speeding may also have caused flutter, which may show itself in unusually loose control surface hinges and other similar damage.

When doing daily inspections and pre-flight checks, be careful not to apply loads which might be well in excess of in-flight or design loads at the ends of control runs; places like elevators and ailerons where, there might be a large lever arm on linkages.

Routine operations

You should look for wear and tear due to routine operations. This could be signs of damage from rocks thrown up by cable drogue-chutes during winch/auto takeoffs, fasteners working loose on fairings or hatches due to operations on rough ground, worn or flat tyres.

Look also for marks on wing-tips where they may have struck a stationary object and for loose or cracked control surfaces which may have caught on plants or hit the ground when the glider was being towed out or back to the hangar.

If you are even slightly suspicious about anything you find on a walk-round inspection, don’t fly the glider, have the defect looked at by an inspector and note the defect in the glider’s maintenance release as a minor or major defect. A minor defect is one which needs attention but does not mean the glider is unsafe to fly. A major defect means that the glider is grounded until the defect is cleared by a qualified person.

It’s better to be down here wishing you were up there than to be up there wishing you were down here.

Daily inspections

It is a GFA requirement that all gliders receive a Daily Inspection (DI) before flying. If there is a defect, minor or major, the DI is both the best time and the most likely time to pick up a problem and stop a potential accident. The person carrying out the inspection must be adequately trained and hold a Daily Inspector authorisation.

A Daily Inspection is required:

- Before the first flight of the day.
- After any rigging of the glider.

A good Daily Inspection helps prevent accidents by showing up faults in a glider before it flies. A person holding DI authorisation plays an important part in safety and accident prevention. During a DI, the glider is being inspected for everyone's benefit on that day, not just for one individual so it’s a job which needs doing responsibly.

It’s very much in your interest to get authorised to perform daily inspections. Most importantly, if you are flying the glider, you are the person most interested in making sure it’s airworthy! It’s useful for clubs to have pilots who are trained in daily inspections and routine glider maintenance, and all pilots should become daily inspectors.

Becoming a Daily Inspector

To become a daily inspector you need the following:

- To be a member of GFA.
- To be a solo pilot or have suitable background experience (e.g. a L.A.M.E. or aircraft apprentice) to assist in obtaining the authorisation.
- To be at least 15 years of age.
- To satisfactorily undertake a DI test by Daily Inspector examiner.

DI Training

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 so you can learn about DIs during normal flying training. The reference for DI training is the Daily Inspector handbook which can be got from the GFA.

When DI training has been completed you can take an independent competence test. If the test is satisfactory, your logbook is appropriately endorsed. If not satisfactory, you will go back for further training.

The practical side of Daily Inspections

There are five reasons for carrying out a Daily Inspection.

- To check for progressive deterioration caused by normal wear and tear.
- To check for unserviceable parts or sudden deterioration which fall outside the category of normal wear and tear.
- To check for unreported damage.
- To check that the glider is correctly rigged and that the control circuits are properly connected and locked.
- 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 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 get an in-depth inspection at least once a year. The DI bridges the gap between the walk-round inspections before flight and the annual inspection.

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, particularly rudder and tow-release cables.
- Lack of lubrication. This might include anything from airbrake controls to slides used to adjust rudder pedals.
- Dirt in control circuits.
- Excessive free play in hinges and bearings.
- Signs of fatigue in structures and controls. This might include items like excessive play in the wing roots to fatigue cracks in airbrake arms.
- New or growing cracks at stress points in structures. Commonly cracks might begin at airbrake boxes and on the tail boom at the fin join.
- Loose or improperly fitted fasteners. An example of this might be castle nuts without split pins or nylocs with inadequate thread count above the nut.
- Frayed or worn harnesses.

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

Unserviceable parts and sudden deterioration

Examples of sudden deterioration include :-

- Broken release springs in tow releases.
- Water or insect nests blocking pitot/static systems.
- Instrument or radio failure.
- Flat tyres.
- A failed component in a control circuit.
- Flat or dead batteries and blown fuses.

Again, not the full story but an idea of what can happen suddenly and unpredictably in normal service.

Unreported damage

Unreported damage is outside the category of normal service wear and tear and occurs when the glider is either flown outside its permitted limits or is damaged in some way on the ground or when landing.

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

Looking for unreported damage is not meant to be a witch hunt! It's possible to pull the brakes on too hard during a landing roll, rock the glider over onto its nose briefly and recover without realising that there's a scratch in the gelcoat. We're looking for damage to make sure the glider does not fly if there's something wrong, not for someone to blame for this.

Correct assembly and rigging

Most modern gliders have automatically connecting controls so that when the glider is rigged, the ailerons, airbrakes, elevator and flaps are automatically connected. However this is not always the case, especially with older gliders. There are very few badly designed auto-connects which can result in errors. Occasionally a fault can cause incorrect connection.

In many gliders, the controls have to be connected by hand and in some cases this is done only by feel. So whenever a glider is rigged and at each daily inspection, it's essential to check the controls and have someone double check this.

It's most important to make sure that controls are properly connected both in terms of ensuring that the connection is solid and the parts are connected in the right sense… so when you move the joystick, the control surfaces move in the right direction.

Control surfaces are checked by first making sure the control surface moves in the right direction and then to check the security of the linkages.

One person operates the controls in the cockpit and confirms that the controls move in the right direction and then with a second person firmly restraining the control surface, the person at the controls applies suitable pressure to make sure the control linkages are properly connected.

There should be no restriction in the movement of the controls and the range of movement must be normal and correct.

Cases have occurred of gliders becoming airborne with reversed controls, having escaped several stages of inspection. Before you move the stick, think which way you expect the control will move. Some pilots will speak out loud "to me, to me" when they move the stick and watch the control surface to make sure it moves towards the stick.

- Make sure wing pins are safety-locked and any tapered pins are fully home
- Check to see that locknuts are in safety.
- Check to see that turnbuckles are correctly locked and in safety.
- Check to see that castellated nuts are properly connected and safety-locked.
- Make sure that hatches and access panels are securely fastened after use.

Loose objects, tools, etc

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 and coins falling out of pockets can work their way under floorboards and end up among push rods, 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… Before you start DI training, watch other pilots DI gliders and afterwards, ask them about anything you saw them doing which you didn't fully understand. You can learn something from everyone.

Talk to your club instructors or airworthiness inspectors about becoming a Daily Inspector. DI training gives you 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 such as a Parts Replacement or Form 2 inspector's ticket. It will also make you a more informed and sympathetic pilot.

For more detail on maintenance of gliders refer to the Registered Operators Handbook or for the Airworthiness procedures refer to the MOSP (Manual of Standard Procedures). There are also other manuals in the current MOSP to assist you with Airworthiness such as building or registering a glider or Daily Inspection. All are available online on the GFA website.

Staying Up

Soaring

This is the Really Important Chapter… because most people who go gliding want to say up in the air and to begin with, staying up is not always easy.

We'll call this soaring now to differentiate short 'sled run' gliding flights where the aircraft is just sliding downhill from much longer soaring flights where there are phases of climbing in lift and phases of gliding between sources of lift.

There are no "natural" human soarers but you will soon learn to recognise sources of lift and to soar better than any soaring bird… at least in terms of time, speed, distance and altitude.

There are a few key concepts you need to get when learning to soar. Normally, when you are learning to glide, you don't get much practice in soaring. It's all circuit bashing. Then, when you go solo, you are let loose to discover soaring by yourself… which can be demoralising.

If you understand these key concepts beforehand, your chances of getting good enough at soaring to enjoy yourself are much better. That's why a few days in a two seater with a good cross country pilot can be an excellent plan when you're immediately post-solo, just to get a grasp on these ideas.

The first concept is to have a rough idea about where usable lift is to be found and also where you're likely to get sink. Fly in the former and avoid the latter! Here in Australia, there are three main forms of lift; thermal, ridge and wave. Here, we're mostly talking about thermals.

The second concept is to have a rough idea about the shape and behaviour of thermals.

The third concept is to learn to recognise the feel of a lift source like a thermal, not using instruments like varios and glide computers but by using your senses and to differentiate between a thermal and the turbulence between and surrounding thermals.

The fourth concept is to have a rough idea about how to get the glider flying in the lift source and climbing which means in the case of a thermal, using the sound of the vario to circle in the best part of the lift.

It's the third of these concepts which is often the most difficult to grasp, for a number of reasons. The first being that you cannot really understand what it feels like when you are flying into a thermal until you have done it a few times. Next, the difference between turbulence and lift can be slight and difficult to differentiate at first and finally, a two seater is nowhere near as sensitive a tool for detecting a thermal as a well balanced single-seater.

You may note that the phrase 'rough idea' is used in connection with three of these four concepts. That's because you really only need a rough idea.

For a start, lift and thermals are illogical creatures and hardly ever follow our rules. Yes, they often do, but there are probably more exceptions to each rule than agreements.

But if you have a rough idea of where to find a thermal, if you can get a glider flying roughly in a circle, if you have a rough idea of what a thermal looks like and how to bank a glider into it and keep it roughly climbing, you're well on the way to becoming a soaring pilot.

It's only the "feely" third concept which can be elusive and there are days when even the best pilots come home, deluded by clouds and frustrated by turbulence, wondering if they know anything at all. That's why we keep coming back for more.

There's one thing which almost all good soaring pilots have in common and that's an enormous sense of optimism that they will always find a thermal. Occasionally they do not, but most of the time, they do and there's no doubt that an optimistic attitude helps, but you're probably not going to have that attitude right away.

Accurate flying

In order to stay in a thermal you must fly as accurately as you can. Your circling must be smooth and well coordinated with a constant angle of bank, attitude and airspeed… not so easy if you are just beginning. However, just knowing you have to fly accurately is a good start.

Visualisation and feel

It's said that thermals are bullies and will try everything to throw you out. That's true of many thermals so you need to be prepared to lose thermals after you have joined them. A large part of the key to finding them again is visualisation. As soon as you can, make a mental picture of the shape of the thermal you are in, where you are circling in relationship to the ground, the cloud or to the turbulence in the air. Then, if you do get thrown out, you will have a good chance of getting back in quickly.

Thermalling is all about feel. Feeling the glider and feeling the air. Thermalling has very little to do with instruments and little to do with anything you can see. Of course you should look outside and only glance occasionally at your instruments but mainly you should try to feel what the glider is telling you. With its huge wingspan, a glider is like a water divining rod in the sky, sensitive to the smallest vibrations in the air. It's your job to listen to it.

You cannot expect to feel a thermal if you are gripping the joystick as if you were trying to strangle a python. You need a light grip and a still arm. This is discussed in greater detail later. And of course you need a degree of optimism and confidence in your own ability.

An interesting technique to learn about the feel and structure of thermals is to leave a good thermal, pull dive brakes to lose a few thousand feet and then try and find it again. A good learning tool but there are few pilots who pull airbrakes after getting a good climb!

Lift Sources

There are three main sources of lift; thermals, ridge lift and wave. Thermal lift is the most common form of lift used for soaring in Australia. For most of us, thermal soaring is why we go flying. We return again and again to the ever-changing mystery and challenge of winning enough energy from the atmosphere to let us stay up all day in our playground in the skies.

Thermal soaring can appear to be a mystery at first. Where are thermals? How do they start? How do you catch them? And while you are struggling to stay in the air, other pilots are returning from flying hundreds of kilometres. How do they do it?

When you first start catching thermals, it's probable that you will lose almost as many as you find unless they are big and benign. The really important thing is not to let yourself get discouraged. Talk to an instructor. Ask a more experienced pilot to mentor you. Talk to a coach or pair fly.

Pair flying or flying in a two seater with a more advanced pilot, an instructor or a coach is a great idea, especially if you are nervous about flying away from the field. Flying with a pilot who is better than you is a sure way to catch some of their optimism.

Thermals

In this chapter, we'll look at what a thermal is, how thermals are formed, how to find one and what to do so you don't lose it. There are a few things to think about first.

A thermal is a mass of warm air which moves upwards through the atmosphere, expanding and cooling as it goes, until it reaches a point where it is the same temperature as the surrounding air.

Scientists had suspected the presence of thermals but it was in 1928 at the Wasserkuppe meeting in Germany that pilots and organisers decided to seriously investigate the possibility that cumulus clouds were formed by up-currents of warm air and that these might be strong enough to support a glider. The results were spectacular and within a year the gliding movement was freed from slope soaring to explore the skies.

Since then, people have spent a lot of time doing research into the formation and shape of thermals so we do know something about their shape and it is essential to have a mental picture about what a thermal looks like before you go hunting them.

Inversion layer

Inversion layers are areas in the atmosphere where the normal decrease in air temperature with increasing altitude is reversed and the air at the inversion layer is warmer than the air below. Usually the air near the surface of the earth is warmer than the air above it because the atmosphere is heated from below as solar radiation warms the earth's surface.

As the ground heats up over the day, rising thermals warm the atmosphere and the inversion layer rises or dissipates over time. Inversion layers can form overnight and in winter when the sun's angle is low and ground heating is limited.

Inversion layers are important to soaring pilots because they limit the height to which thermals can rise. On days when there's a strong temperature inversion, the atmosphere is said to be stable and soaring conditions are unlikely to be as good as when there's little or no inversion layer.

When the lowest levels of the atmosphere are warm and humid and the vertical temperature gradient allows thermals to continue to rise, the atmosphere is said to be unstable. Generally, unstable conditions are great for soaring to the point where the instability causes thunderstorms.

The lifespan of a thermal

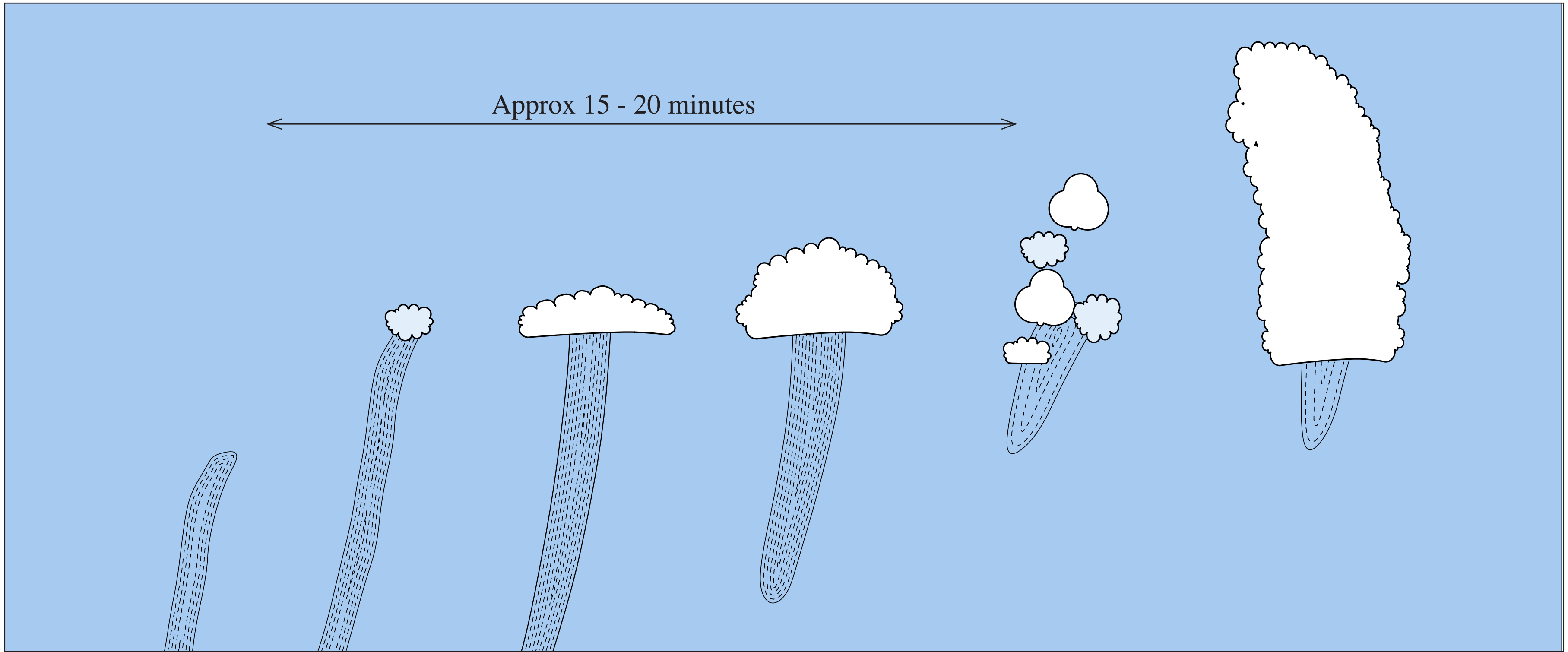
Thermals have a life span. On a good day, each thermal is marked by a cumulus cloud (CU) at its top. The cloud will form as a few wisps, grow outwards and higher, becoming more dense and white and then normally it will thin out, break apart and disappear.

The cycle time of thermals changes depending on meteorological conditions such as humidity and it may be as short as ten minutes or an individual thermal may appear to last all day.

Of course there are thermals on blue days too. In fact, bearing in mind how many clouds don't work, flying on blue days can be very productive!

If the day is blue, most thermals will rise as high as the inversion layer but just as on a cloudy day, some may have enough energy to burst through and if you are climbing in them, you can go many thousands of feet higher than "cloud base" on a blue day. Just be aware how this happened and don't expect to find many thermals until you descend below the inversion layer again.

The Life of a Thermal under a Cumulus Cloud



A thermal which is topped by a cumulus cloud (CU) makes it easy to visualise the general structure and life of a thermal on any day.

Small, wispy CUs appear when the thermal feeding them reaches a height where it's cool enough that water vapour condenses into droplets. The thermal which feeds the young CU may be strong but narrow. As the CU develops, its base flattens and it spreads out sideways and vertically. A wide, flat CU normally means a weaker thermal. Clouds that build vertically with solid, dark bases are often stoked by powerful thermals. These can make the base of the cloud dome upwards with the strongest lift at the centre of the dome.

If you're well below a lovely looking CU, be aware that the thermal may have already exhausted its supply of warm air on the ground and not be working at your level. Towards the end of the cycle, a cumulus cloud begins to break apart and the lift underneath it will weaken a lot. On some days, where thermals trigger repeatedly from the same source, you may find a young flat bottomed CU forming in almost the same place amongst the ragged remains of the old one.

Tall CUs which extend well above their surroundings are generally a disappointment and should be avoided.

Thermal sources and triggers

A thermal is formed by a mass of warm air leaving the ground and moving upwards. We refer to where this mass of the warm air sits as the thermal source. The event or landscape feature which causes the warm air to leave the ground is called the thermal trigger.

As soon as you release from tow and the aircraft is trimmed, the first thing you will want to do is to look for a thermal so you can climb higher. If there are CU around, you will be tempted to aim for one of them, but this may be a delusion.

The thermal which caused the cloud far above you may already be too weak to work at the level you are flying. In most cases, low down, your best bet is to look for where a thermal might start from on the ground… the thermal trigger.

When you fly close to the ground, even if there are plenty of clouds above you marking thermals, you always keep an eye on the ground for thermal triggers as well as outlanding opportunities… one may save you from needing the other.

Although thermals are just warm air, the air in a thermal is not warmed by the sun… it's warmed by the ground and the ground is what's warmed by the sun. A patch of ground becomes warm and this in turn heats the mass of air lying directly on top of it. Air is a great insulator, so it's easy for the low-lying air to warm up without losing much heat to the air above.

The shape and texture of the landscape can help retain or stabilise this mass of air as it warms up. The warm air may be pooled in a depression in the landscape or trapped between the stalks of a wheat field until something causes the air to start rising.

Low-down, what you want to look for is an area likely to be able to retain and warm up the over-lying air and something which is likely to trigger this air into leaving the ground.

It's said that to assess the suitability of a thermal source, one should take a mental walk on the ground and imagine what it feels like down there. Well, on most Australian summer days, the chances are that everything on the ground just feels hot. Very hot.

And if you ever fly in remote locations where the ground looks identical for hundreds of kilometres in each direction, you might find it difficult to see an actual trigger on the ground. But it is possible that the trigger is just wind on the ground, stirring things up rather than a feature in the landscape.

Nevertheless, there are places on the ground which you could guess would be an attractive place to start if you were a thermal.

Around most flying sites, there are what's known as "house thermals". Places where a glider can go with a very high probability of finding lift. No doubt you'll get a close look at these during training. Make sure you analyse the local landscape to try and understand why these types of thermals are so reliable.

A number of factors go into making something on the ground a good thermal trigger and most of them are to do with the ability of the area to absorb heat or to form a physical trigger in some way. These include the shape and colour of the ground, its composition, vegetation cover, moisture content and the angle at which the sun's rays strike the surface. Note that most of these factors are easily visible so it's not too hard to see likely thermal triggers.

Colour

It is well-known that darker colours absorb heat better than lighter colours. The same applies to the earth's surface. Dark earth colours absorb more heat. Lighter colours absorb less heat and reflect more of it back to the atmosphere where it is lost (at least to glider pilots).

To be honest, there are times you can fly over a black coal dump and get sink and times when you get lift off a snow field… A black field may mean the soil is soaking wet… But like other factors talked about here, dark ground colour is a clue, but not a guarantee.

Composition

The shape, composition and texture of the surface affects the rate of heating. Rock outcrops will heat up at a different rate from loose sand but both can serve as good thermal sources. A solid lump of western facing rock on a lee-side ridge might be a very attractive place in the afternoon.

Lakes, wet fields and damp soil are generally useless as thermal sources in the middle of the day. They absorb most of the solar energy that hits them and even in summer, remain cool. But oddly, late in the day, damp areas can produce useful thermals because they lose heat more slowly.

Vegetation

Crops with stalks are often thermal sources. They don't reflect too much heat energy and the soil below doesn't conduct much heat away from the surface. If the crop is reasonably tall, it can trap heated air for long enough to form a thermal bubble, which only needs a trigger to leave the ground.

During the day, trees use up much of the solar energy which falls on them and not much reaches the ground. However wooded areas can often be relied on later in the day to provide quite large areas of gentle lift.

Moisture content

If there is water lying around or a lot of moisture in the soil, much of the sun's energy will be conducted away from the surface or used in evaporation and little or none may be left over to heat the surface. This is why irrigation areas are rightly regarded as sink-holes for glider pilots.

The angle of the sun on the ground

The shallower the angle at which sunlight strikes the ground, the less heating effect it will have, so the greatest solar heating will be some time after noon when the sun is directly overhead.

East facing hills and slopes may produce useful early thermals and west facing hills and slopes will work in the afternoon.

Thermal Triggers

Assuming you have this great lake of warm air lying peacefully on hot ground just waiting to become a thermal… what is the trigger which makes it surge upwards, hopefully carrying you with it? Of course it would too easy if there was just one type of trigger, but there are many and their ways are only partly predictable.

If there's wind, the pool of warm air may move slowly across the ground, getting warmer and more unstable until it meets some shape, some element in the landscape which angles it upwards causing lift-off. This may be something as simple as an exposed rock or a few trees at the corner of a paddock or it might be just a change in the local wind. Thermals commonly track up a gullies and ridges which channel the wind-blown air upwards to form a thermal.

Thermals can form at the junctions of different, unevenly heated terrain for example where a field meets a wooded area or where a lake meets the bush. Straight lines formed by roads, the edges of forests and man made features in the landscape can be reliable triggers.

Thermals can be triggered by moving objects in the landscape such as vehicles. Ploughing tractors and tow vehicles are common sources.

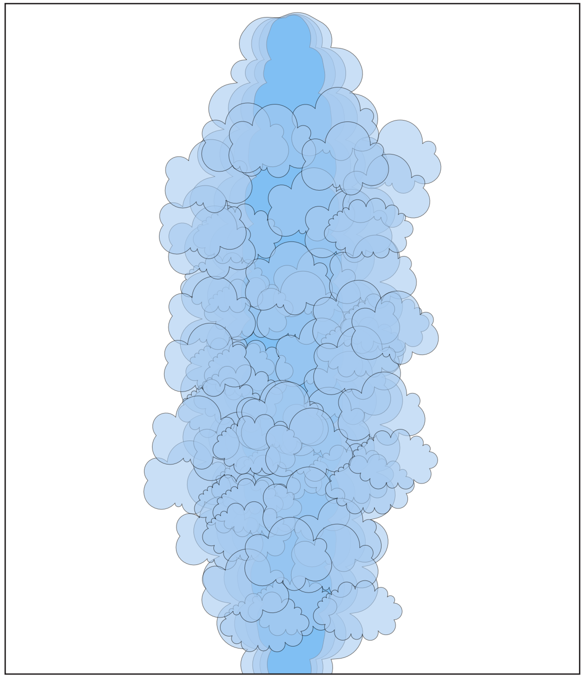
Thermals very often form in the lee of hills and ranges where large pools of air can get nicely heated.

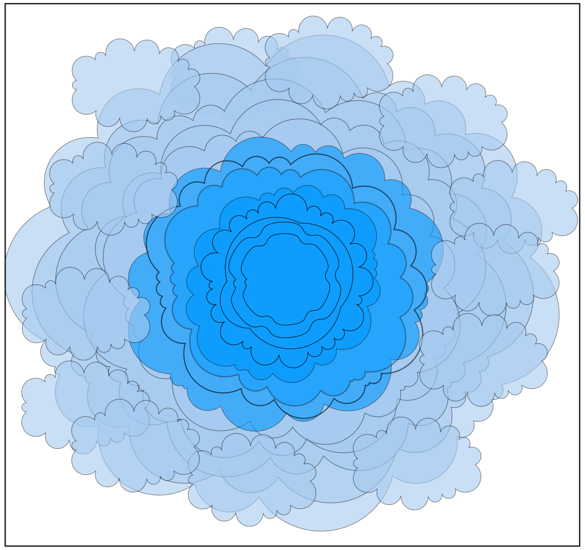
When the wind is strong, thermal triggers may work well but the resulting thermals can be broken up and have difficulty getting organised low down. When they do form, they'll lean back from the trigger point at a steep angle. The problem in a wind is that unless the thermal is strong, the drift downwind as you circle may be too great to be able to make up for on the glide.

This trigger stuff is all good but if you take into account the life-cycle of thermals, you'll realise that only a few of these thermal triggers and sources will be active at any one time. You need to develop a disciplined approach to searching for thermals. Look for trigger points and search on the downwind side for signs of thermals but move on to the next possibility if you find nothing.

The shape of thermals.

The shape of thermals varies a lot and in some parts of the world they are different to others. In Australia, they are probably shaped like a cabbage… a cabbage with a long stalk.





Sometimes they may be more like a doughnut and sometimes more like a cabbage with three long stalks. But since thermals are moving, short lived and invisible, it's difficult to be proved too far wrong on this.

We know two things about thermals. The centre is going upwards, often quite fast, and the outer area, beyond the thermal is either not going up, or actively sinking.

It's common to draw thermals as an elongated tube or bubble but we know from watching a fluid like water, that this type of motion must result in turbulence between the two opposing flows. You can easily visualise this behaviour by running a tap hard into a clear container which is full of still water.

Where the fast-moving stream meets the stationary fluid, clouds of turbulent vortices will result, which occupy a larger area of the cross section than the laminar flow in the centre or core. Pictures of explosions, mushroom clouds and bushfire columns show this same appearance and it seems logical to believe that this is what thermals look like.

A more or less smooth inner core of rising air will be surrounded by a turbulent zone where the rising air meets either still or sinking air around it. The reason having a clear mental picture is important is that it makes it easier to feel thermal structure when flying in your glider using the most basic instruments.

Finding a thermal

As you are flying along, looking for a thermal, you're actually sitting right on the best thermal detecting instrument yet discovered… and it's not the seat cushion.

The fact is that you feel a thermal in the seat of your pants well before the glider and your instruments react. It can be difficult at first to separate the many sensations and sounds when you are new to gliding but if you know what to feel for, it will make things so much easier.

People will tell you that some gliders "talk" to the pilot and it's true that some gliders give excellent feedback about the air you are flying through even if in rough air this can be too much information!

Get into the habit of flying with a light touch and feeling the glider as an extension of your own body. If a wing lifts or the glider pitches down, before correcting, ask yourself… "what air movement could have made this happen?"

As you approach a thermal, you are likely to fly through an area of sink and surrounding turbulence and this turbulence can often be the best indicator of lift somewhere in the vicinity. As you fly through the air surrounding a thermal, the glider will vibrate in a pattern which is so predictable that you can easily read the signature of a thermal in the air.

You may hear the vario making sounds and the needle jerking rapidly. This may be just false readings caused by horizontal gusts in the turbulent zone outside the real thermal. Learn to recognise these gusts as false indications.

A total energy vario reacts differently to the vertically moving air in the centre of a thermal or the swirling air in the turbulent zone at the edges of a thermal. A total energy vario sees the horizontal gust component of a turbulent eddy as a sudden increase or decrease in energy.

The result is that the vario needle flicks rapidly up and down and the vario beeps suddenly for lift or sink. It's easier to see this on a mechanical vario needle than an electric one and only a short glimpse at the rapidly moving needle is enough to tell the story… it's turbulence, not lift.

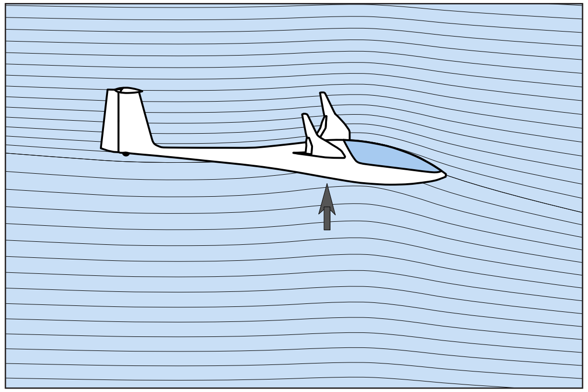
This rapid flicking is quite different to the more or less steadily increasing lift that is registered by the vario when entering the laminar core of a thermal.

When you are learning or later on, when you are very keen to get a climb, it's easy to mistake these fool's thermals for the real thing which almost always gives a smoothly increasing sound from the vario.

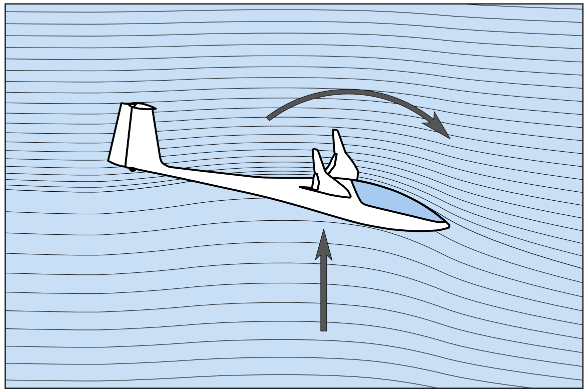
As you fly near a thermal, you will usually feel the glider shudder or tremble slightly. This is almost always a good sign and you should prepare to slow the glider down. This may seem the wrong thing to do if you are in big sink but mostly it will pay off. Don't slow down too much though… you still need manoeuvrability and you can sense thermals as easily at 70 knots as you can at 50.

Hopefully, as you slow down, you will feel the glider start to lift. If the glider is reasonably quiet… and you may need the vents closed to really hear this, you may hear the noise of the thermal rushing upwards past the glider.

You may be aware of a slight nose down pitching, as if the glider was being pulled upwards by a string attached just behind where you are sitting.



Then the vario will indicate lift, normally with a steadily rising tone which is markedly different to the sharply rising beeping caused by horizontal gusts.



The seat of your pants detects acceleration very well but once the acceleration is over, your body can't tell if you are moving or not. Think about being in a lift in a tall building.

You will sense that the lift is starting to rise or fall but when it reaches a steady speed, you will cease to feel motion and unless the lift is made of glass, you won't know if you are moving or not.

A vario may react more slowly than your body's sensors but it will give you a good indication of whether you are going up and how fast.

The vario may have a lag of 2-3 seconds, by which time you may have flown through the edge of a small thermal so get used to using your senses to discover when you enter lift and use the vario to tell you the strength and shape of that lift.

Pay attention!

Searching for thermals takes a lot of concentration, especially if you are low down and really need a climb. You'll want to get rid of all extraneous thoughts…clear your head and give yourself the best chance of feeling the air around you.

First, get the essentials out of the way. If you're high enough to continue searching for a thermal but an outlanding is a possibility, continue picking paddocks and checking off their suitability. Mentally rehearse your pre-landing checks, including checking the direction the undercarriage lever works to lower the landing gear.

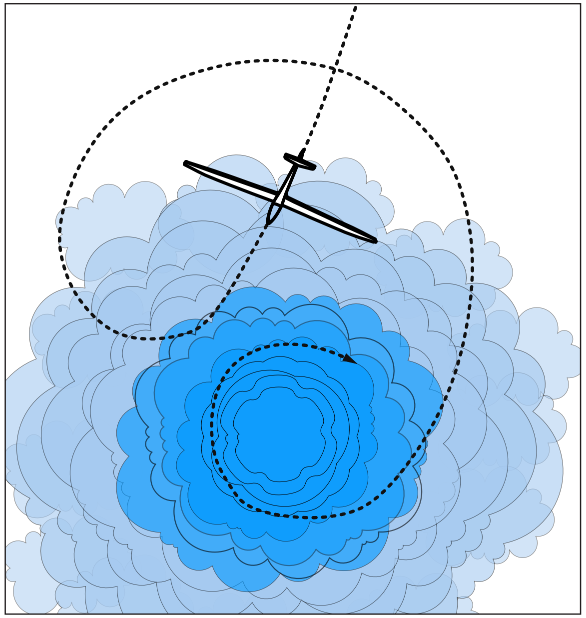
With your landing options sorted out, there's one less thing to think about. Many pilots turn down the radio. There's nothing like hearing how well other pilots are doing when you're grovelling to destroy your concentration.

Some pilots even turn down the vario so the only thing they can hear is the sound of the air moving past the glider and only wind it back up when they're sure the glider is in good air.

Hold the stick with a light touch and concentrate on feeling for some activity in the air.

Unless you are really certain you're in lift, don't turn immediately. You need to make sure that the thermal is large enough to turn in and to make sure that this is really the core and not more edge turbulence. Sometimes you may be fooled by an up-going swirl of air and then fly straight into a down-going one. Sometimes, if a thermal is just starting low-down, you may just be at the top of the bubble so you need to explore for a time.

If you feel a wing rise, turn gently towards the lifting wing because the wing is being lifted by air moving upwards faster on this side. If the wing lift is really strong, you might do better to



let it lift and continue the turn by 270º, coming back into the thermal, and straightening up briefly as you cross the core to centre your circle. It has to be said that wing lifting is less apparent in flexible gliders than in stiff gliders… however the flexible glider may be more comfortable in turbulence.

What happens next may depend on what height you are flying at. If you are close to the ground and need a climb, you may want to make a full search, especially if you have not had a climb for some time. A moderately wide area of rough air is a common sign of a thermal and it's usually worthwhile spending a little time searching… but don't hang around too long.

If you are higher up, then don't waste too much time looking for hard to find thermals, move on.

If you know there is lift about, begin a gentle turn to one side. If the vario sound increases, then continue the turn. If not, do a shallow S turn in the other direction. Hopefully, feeling the turbulence and following the sound of the vario, you will get into a good patch of lift.

If you don't find any move on. What you may be feeling is the wake of a thermal which has already exhausted its supply of warm air.

Like the sea, the air is in constant motion on a warm day with eddies moving up and down all around you. Unfortunately, experience is the best teacher of what is worth circling in or not.

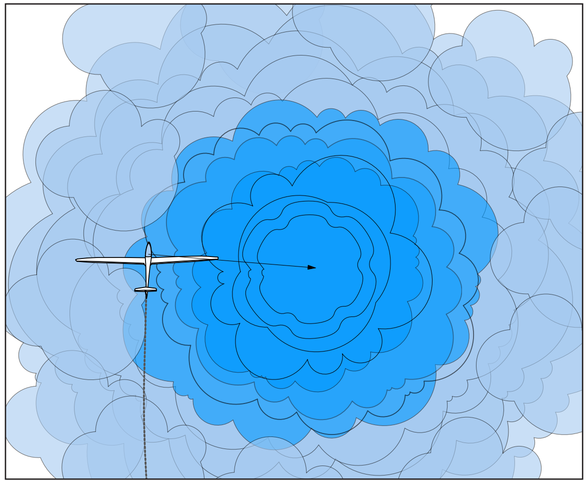
Centring the thermal

Once you have found something which feels or sounds promising, you need to find the best bit, the core or centre of the thermal. The cross section of thermals varies a lot, but you can take it that it's mostly circular and the middle is rising faster than the outside. You want to find the best lift in the centre and make sure you stay in it. The core is likely to be fairly smooth compared with the outer edges and this is one tell-tale that you are in the centre.

Most pilots will agree that if you find a thermal, it's best to get into it as fast as possible, so roll the glider in towards the lift without worrying excessively about the yaw string.

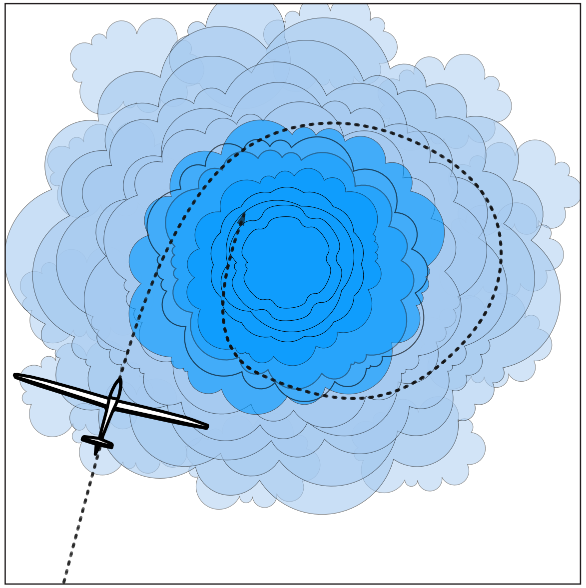
Talk to yourself as you circle to focus your mind. If you are in sink or weak lift and you feel and hear the glider start to climb then the thermal is towards the up-going wing. In this case, many people will be saying to themselves something like… "sink, sink, sink, better, better…"

And immediately the lift changes to "better", look over the down-going wing, the one on the inside of the turn and make a mental note to say "that spot is near the centre of the thermal".



What you do next is open to a lot of debate! You can read a lot of books and they'll offer all sorts of complex methods for centring a thermal and possibly the people who write the books may use these methods. However, the simplest method and the one also used by most flex-wing pilots who don't read these books is to tighten the turn when you hit lift.

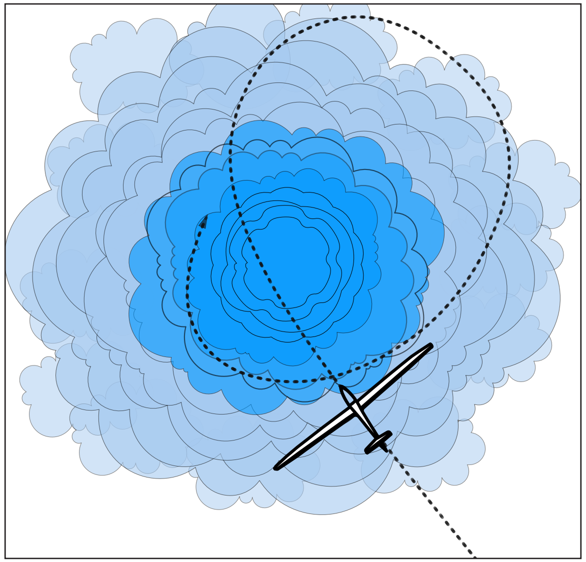
That is to say, when the glider starts to climb, bank more steeply into the turn to approach the core. And if you fly out of the lift, flatten out the turn a little until you circle through something stronger.



The effect of any thermal centring technique is to move your circle over slightly towards the core of the thermal. If the thermal is a gentle one, use light control inputs. If the thermal is rowdy, then be more active.

This 'tightening on lift' technique may not be the most efficient in terms of time spent finding the centre of a thermal, an important thing when you are racing, but it's an easy technique to apply and it does work without a great deal of thinking.

If you are confused centring thermals, it may work to draw a plan view of a thermal on paper and make a flight path with a pencil of a glider approaching the thermal. Then ask yourself at each point, what's the air doing here? Is it rising or sinking? What should I be doing to avoid the sink and optimise my climb rate?



When you first start thermalling, your technique may be purely mechanical but soon, the connection between your senses, the sound of the vario and the feedback from the glider will become an automatic response and you will find that you can in many cases centre a thermal almost without thinking in the same way that you might turn a bicycle.

Build a mental picture of the shape of each thermal as soon as you can. You do this with the sound of the vario, the movement of the glider, and if you are low-down, the position of the thermal trigger if you can see one.

If there's a wind, the thermal will be leaning over. Although the glider will drift downwind at a fairly similar rate, in conditions where there's an inversion or wind shear, the thermal can change abruptly as you climb and you often have to re-centre. The better your mental picture of the conditions, the better you can make use of the thermal.

Bank Angle when thermalling

Most gliders are designed to be banked 40° - 45° in a thermal. This might be difficult to achieve at first. It's probably more important to fly an accurate circle rather than a steeply banked but irregular one. The steeper the bank, the greater the glider's sink rate so bank angles of more than 45° may be self-defeating though in rowdy thermals, a steep bank can make the glider easier to remain centred.

Over the years, as gliders have improved in performance, their best speed for circling flight has increased to the point where many high performance gliders need to be flown at speeds of 55 to 60 knots when banked, making a comparatively wide circle.

Oddly, this means that the glider will be outside the middle of the thermal and will miss the best bits a lot of the time. Older gliders may fly at 34 to 40 knots when thermalling and since they can stay in the more rapidly rising core will often climb much faster. It's short-lived joy, because when the high performance gliders leave the thermal, their faster inter-thermal speed and flatter glide angle means they'll arrive at the next thermal a lot higher up.

It's important to fly smoothly as well as accurately. Part of the reason for this is due to the varios and aircraft plumbing giving rise to vario lag. The more you move the aircraft around, the more likely the vario will give you incorrect readings and make thermalling more difficult.

Low-down, thermal cores are often narrow and rowdy, becoming wider and smoother as they get higher. This may means you may have to bank the glider over more steeply in a low thermal. When you're beginning, this can be difficult to master. Later on, it's just exhilarating.

As an aid to getting the mental picture of the shape of a thermal, listen to the vario. When it indicates the least area of lift as you turn, look across towards the low wing. That wing is pointing to the centre of the thermal. Turn another 90° and roll the glider out for a few seconds, then bank back over.

You should now be closer to the centre of the thermal and your vario, according to the books, will be sounding a constant, welcome chirping. In fact, it's fairly uncommon to find a thermal which is particularly constant and you will normally be re-centring the glider to get the best rate of climb every few turns or so.

Maximising your rate of climb

Depending on where you fly and the approach of your instructors, you may get a headache listening to them carrying on about getting the best rate of climb and wonder what all the fuss is about, especially if you can reliably stay airborne for a few hours when you want to. The reason is this. If you want to fly cross-country any distance at all, the time you spend climbing is time wasted, when you're not flying where you want to go.

It's important to make sure you're in the best part of the thermal. Many top pilots can be seen making a big circle in lift before tightening and centring a thermal so they make sure they're in the strongest lift.

If you fly with a logger of some sort, have a look at the analysis of your flight. If you are a normal low hours pilot, you will probably find that you are spending 40% - 45% of a flight thermalling. Fine, it's great practice and very enjoyable.

However, if you want to fly cross country you have to be more ruthless and get your time spent thermalling down to 30% at the most. This means taking only the strongest thermals of the day, maximising your rate of climb in them and leaving as soon as the thermal slows down.

There is another reason for maximising your rate of climb. Sooner or later, we all get caught low down and looking for a wisp of lift somewhere.

The better your thermalling technique (which means you can centre well and maximise your rate of climb) the better you will be able to climb away on a zephyr of lift and the more confident and more enjoyable your flying will be.

Joining other gliders in a thermal

If you see gliders circling, it's a good sign of a thermal. Before racing over to join them, make sure they're actually climbing. It's not unknown for pilots to circle in sink!

The next thing to be clearly aware of is that other pilots will have the same idea as you and there may be more aircraft flying towards the thermal and other gliders circling in the thermal which you have not yet seen. So look out!

Before you alter course at any time you should always have a deliberate look around, especially in the direction of the turn to make sure that there's no other aircraft around. This is especially true when turning to catch a thermal.

While flying towards circling aircraft, have a careful lookout for aircraft entering the same thermal from the sides, at your height as well as above and below.

It's very dangerous to make a rapid pull up from a high speed cruise to slow down and join a thermal. Another glider could be just above you, completely unaware of your presence.

When joining a thermal where other gliders are circling, you must circle in the same direction as them. Aim to position your glider on the opposite side of the circle from any other gliders at your level.

It is a good idea to make a shallow S turn as you wash off speed when approaching a gaggle. Apart from anything else, your banked wings make it easier for other gliders to see your aircraft. The shallow S turn also gives you a chance to see other gliders who may be joining the thermal from other directions.

To give gliders already in the thermal the best chance of seeing and avoiding you, join at the opposite side of the thermal to any glider at your level.

Flying in close proximity to other gliders in a thermal can be disconcerting. If you are nervous and you are not too low, think about finding another, less crowded thermal.

If you know the other pilots in the thermal, talk to them on the radio, especially if you lose contact. Everyone has to learn to thermal in company at some stage and other pilots will help if they know you are nervous.

Situational awareness is very important when thermalling and you should develop the habit of making a mental map of the positions of other gliders in a thermal and if you lose sight of anyone, get on the radio and let them know… "Mike Tango, Alpha Bravo Charlie, I've lost visual contact. Can you see me?"

Working height band & Critical Rate of Climb (CROC)

When flying cross country, we set ourselves a "working height band" and a critical rate of climb (CROC) based on the conditions that day.

There are several factors involved when setting a working height band. Obviously, the first is the how high you can climb. When there are CU, this means clear of cloud base while on a blue day, it's the top of usable lift. Normally, thermals get stronger and easier to use as they rise but they often weaken some distance below cloud base or become difficult to relocate at the inversion layer.

Based on a few good climbs, you set yourself a working height band and the CROC or minimum strength of thermals that are worth taking in that band. Let's say that you're flying in an area where ground level is 1,000' on a 6,000' day, with 4-5 knot thermals. You might say that 4,500 - 6,000' is your working height band and that while you're in that band, you will not take thermals weaker than 3 knots.

Why? Well the main reason is that you will not fly very fast cross-country if you circle in every thermal you find so it is important to only take the stronger ones while you are in your working height band.

If you don't find a thermal and descend to the 3,000' to 4,500' middle height band, you need to climb back up again and therefore will accept weaker thermals.

Below 3000' you're grovelling! At 2,000', you are going to be setting up a landing so at 3,000' you'll take almost any lift to get back up to your working height band.

There's an easy rule of thumb to work out CROC. It's 2 less than your height above ground in thousands of feet. So at 2,000' AGL you'll take anything. At 3,000' you'll take 1 knot, at 4,000' AGL you'll take 2 knots and so on.

Later in the day, when thermals are smoother and further apart, you may have to adjust CROC downwards.

Most of us want to be as high as we can get, though on some days the flying is better in the middle height band… for a start, it can be easier to pick good clouds when you can see their bases and some days, thermal strength can weaken with altitude. On weak, grey days with overdeveloped clouds or a large spread-out, your working band may be much narrower, and you'll be flying closer to cloud base at the top of legally usable lift.

Locating thermals higher up

As you may have gathered, there's not much you can guarantee when thermalling and there's a great deal of variation between individual thermals and different days. Clouds are one of the biggest variations.

On a textbook day, you will find lift more or less under the darkest part of fattest clouds. Other days, you may find that the best lift is on the upwind edge of clouds or that most clouds are just fluffy bags full of sink.

Part of the reason for this great variation is the humidity level and temperature gradient which affect the life cycle of thermals. The normal cycle time might be 20 minutes but on days with short thermal cycles, CU may form just as the thermal which is feeding them is turning into sink lower down.

Get used to looking closely at clouds as you fly, especially while you are turning, so you can assess their life cycle.

The rule is, as soon as you get lift under a cloud on the first good climb of the day, have a good look up at base of the cloud you're approaching and ask yourself;

- Where is the best lift? At the centre of the cloud or at the edge?
- Where is the wind blowing? Is the lift on the upwind edge or somewhere else?
- Does good lift go all the way up or does it weaken some hundreds of feet below the top of usable lift?

The good news is that the answers to these questions are likely to remain valid all day.

You should always fly clear below clouds in accordance with Visual Flight Rules (VFR) rules. When flying near cloud base, your white glider will be difficult to see. If the bases of the clouds are clearly defined, it's fairly easy to fly clear of them but if the bases are wispy and vary in height, you should fly in the clear air below so you're visible and you can see other aircraft.

There are pilots who don't like blue days when there are no CU to mark the thermals, but if clouds just mark sink, you can be better off without them. There are often plenty of thermals around on blue days and you may fly better without errant CU to lead you astray.

Flying cross-country on high blue days can be an exhilarating and frustrating experience because you're relying only on the feel of the glider and later, the sound of the vario. Lower down, you can look for thermals based on the colour, shape and textures of the ground but high up, it's just feel.

When looking for thermals in the middle height band, it can be tempting to weave about looking for signs of lift. Generally, this does not work and your chances of finding a thermal are just as good if you fly straight.

Blue days can teach you this technique. You do have to fly with more sensitivity, letting the glider talk to you and using the feedback though the stick, vario and seat to give you clues about where the thermals are rather than just aiming for the next good-looking cloud.

Losing thermals

Sooner or later you will lose a thermal. Hopefully less often as you gain experience! On a blue day, it may be that the thermal has expired when it reached virtual cloudbase. You may have lost the thermal while it shifted at the inversion. Or you may simply have fallen out of the side. This is the most usual cause of losing a thermal. If there are other gliders above you, assume it's true.

The technique of re-finding your thermal is not a great deal different to finding it in the first place. If you have been paying attention to your surroundings outside the cockpit, you should have a rough idea of where you were turning over the ground below and under the cloud above you and it shouldn't be too hard.

Keep flying in a shallow turn. If you can stay in zero sink, then the immediate pressure is off. Do a regular search pattern feeling for the tell-tale signs of lift in the motion of the glider.

Remember that if there is wind around, especially if there is a wind gradient or inversion, that thermals don't rise straight up. They will lean downwind but may also have a dog-leg or bend where the wind speed or angle varies. In this case, extend your search up and downwind.

An obvious question to ask is "was it a real thermal?" You may have been turning in something less than a real thermal such as a single bubble or maybe a surge of wave lift. Unless the ground is completely flat, there's always the chance of a little wave coming off a hill or range some distance upwind.

Finally, unless the sun is really low, don't panic! You've found a thermal before and you can find one again.

If you find you lose more thermals later on in a flight, it's probably because you are tired and not flying as accurately as you could. GPS flight loggers are a great aid to evaluating your thermalling performance, but after the event.

If the trace on your climbs look like a new coil spring then you are probably flying well enough. If the trace looks like you trod on the spring, then you need to practice more (or eat and drink something to get your energy level back… see the section of gliding physiology.)

Keep your eye off the ball

Gliding is not a ball sport! When you are thermalling, you should not be transfixed at the cloud above you but searching the sky for the next good looking cloud and the one after that.

If you look at a picture of a world champion motorcycle rider, knee down in a corner or a top surfer cranked over in a bottom turn, almost horizontal against the surface of the sea, you'll see that they're not looking at the turn they're in, their eyeline is way beyond, at the next section of the track or wave.

When you're thermalling, you should be constantly evaluating the next leg of your course. You should watch the development of clouds around you and those many kilometres ahead, looking for lines of energy and try to leave the thermal you are in with a clear idea of where you're going next.

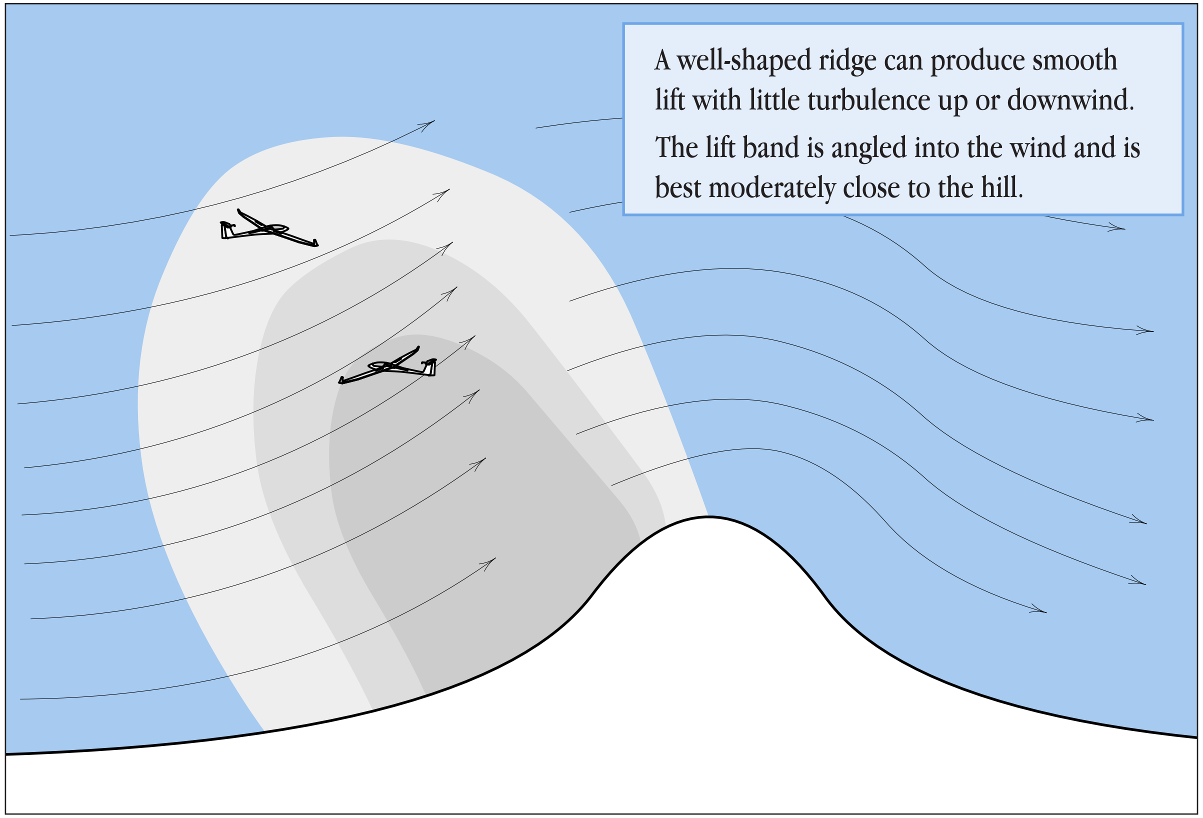
Ridge Soaring

The first type of soaring was hill or ridge soaring and this was the way that Lilienthal and the Wright Brothers learned to glide. Before thermal soaring was discovered, ridge soaring was the only way to stay up in a glider. It's still the principal type of soaring used by hang gliders and paragliders on the coast and on ridges all over the world.

There's a different mind-set involved with ridge soaring. It's undoubtedly thrilling since you're flying so close to solid objects. In other parts of the world, people learn to fly from the start on ridges, but you do need good technique both for flying and landing since a landing may be only one bad turn away… If a turn is not properly coordinated and you get close to an incipient spin and drop a wing, the glider may lose so much height that you to have to set up a landing immediately.

On the other hand, gaining confidence flying close to the ground when ridge soaring can be a good thing. If you only fly at thermal sites, your final turn is the closest you ever get to low flying.

It's assumed here that if you are going to ridge soar, that you will be flying at a club with instructors who are experienced ridge soarers. The time NOT to learn to ridge soar is if you are getting a bit low after on a thermal flight and start thinking that there might be a bit of lift on them thar hills!



When a wind hits a ridge of the right shape, the wind is deflected upwards. There is an area called the "lift band" above of and in front of the ridge which can generate enough lift to support a glider.

In good conditions the lift band can extend many times the height of the hill which generated it.

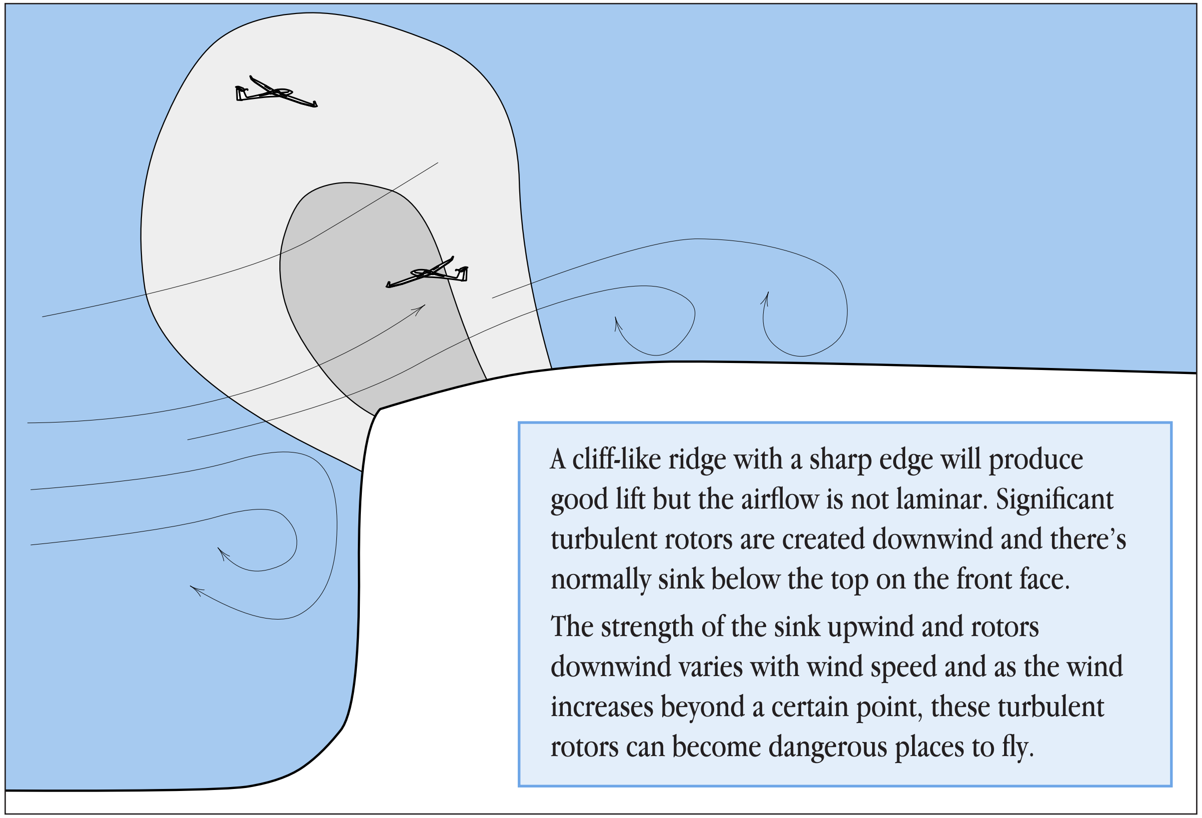
The shape of the ridge is critical. Ideally, it is a smooth sine-wave shape, gradually getting steeper as it rises from a flat plain and then rolling smoothly over at the top. This shape can be expected to give smooth and predictable lift with few rotors or turbulence.

A ridge which rises abruptly from a plain or which has a bluff cliff-like edge at the summit will generate less lift than a much lower smooth sine-wave ridge especially in stronger winds. Most importantly, there may be large areas of turbulence at the top and the base as well as areas of sink on the front face below the bluff summit. This effect will vary with wind strength.

As the wind speed increases above a certain point, perhaps 12 - 15 knots, depending on the ridge, the conditions will change. What may have been smooth laminar flow over a ridge producing great lift, may drop off as the wind increases.

Cliff-edged ridges will develop strong rotor either side of the ridge. On the front face, there will be a height above which you'll go up but below which you will go down very fast indeed. When you are clear above ridge height, you can relax, but only a little.

Strong winds will produce strong turbulence from obstructions in front of the ridge and if the top is a cliff edge, powerful rotors can develop downwind of the front face. Only the smoothest of sine-wave ridges produce no turbulence downwind. In any case you should expect sink somewhere behind a ridge. Be very aware of this if you think about overflying a ridge.



A cliff-like ridge with a sharp edge will produce good lift but the airflow is not laminar. Significant turbulent rotors are created downwind and there's normally sink below the top on the front face.

The strength of the sink upwind and rotors downwind varies with wind speed and as the wind increases beyond a certain point, these turbulent rotors can become dangerous places to fly.

Heavily wooded ridges will slow down the wind and produce less lift than a smooth ridge. Trees on the ground in front of a ridge will slow the wind down and cause turbulence low down.

Wind prefers to blow around hills rather than over them. If there are gaps in a ridge, expect changes in the wind direction and sink near the gap. If you want to cross a gap, make sure you have enough height or turn back before you get too low. This effect will also vary with wind strength.

If the wind is not square to the face, it will produce a lot less lift. Even a wind blowing 20^{o} off will produce less lift and more than 30^{o} off the ridge may be un-flyable. It's important to recognise this before you approach a ridge looking for lift.

In a light to moderate wind, if you are below the top of a ridge you may have to get very close to the ridge when climbing, especially those with cliff edge ridges. This can sometimes mean flying less than half a wing-span away from the rocks. It's absolutely essential when flying like this to have a good reserve of speed… typically no slower than the safe speed above the ground + half the wind speed.

In the right circumstances, you can get thermals superimposed in ridge lift. The thermal will often lift off a spur in front of the ridge and run up the face. There are a couple of possible issues with this. One is that thermals cycle and when you are in a sink cycle it may reduce the overall lift off the ridge.

The other issue is that if you are above ridge height, you can turn in the thermal but you'll drift downwind fast. You should make sure you have enough height to get back to the face if you need to and remember, there's normally a lot of rotor and sink behind the face.

If the airstrip is on top of the ridge, you should make sure that you have plenty of height before attempting to land.

Ridge flying requires special knowledge and good technique and since there are so many environmental factors, local knowledge also plays a big part so there are some rules specifically for ridge soaring.

- Until you are well above the ridge, all turns should be made into the wind, away from the ridge. You fly a series of beats up and down the ridge in the form of a stretched figure 8.
- If you are not the only glider soaring the ridge, you need to keep an excellent lookout and keep a mental picture of where the other gliders are along the ridge because you will only be able so see those in front of you.
- If you are going to overtake another glider, you should do it by passing between the other glider and the ridge. Be aware that you may feel the wake of the other glider as you pass through.
- If two gliders are flying towards each other on a ridge, the glider with its right (starboard) wing towards the ridge has right of way and the other aircraft should give way, turning out from the ridge. This can result in a loss of height and a small ridge may not be able to support many gliders in light air.
- If you are flying on a ridge in the company of other gliders, be predictable.
- Try and turn at the same point they do and don't make radical changes of speed and direction.
- When ridge soaring, a glider shall not be flown lower than 100' above the ground and 100 metres horizontally from a person, house or road.

Wave Soaring

Wave soaring was the third type of soaring discovered in Germany in the mid 1930's. In a region close to a gliding club, there was often a strange shaped cloud. Locals had known the cloud so long that they gave it a name, the Moazagotl.

One day while teaching at the gliding school, an instructor saw another glider rising in lift while flying in a straight line. He immediately climbed into a glider and launched.

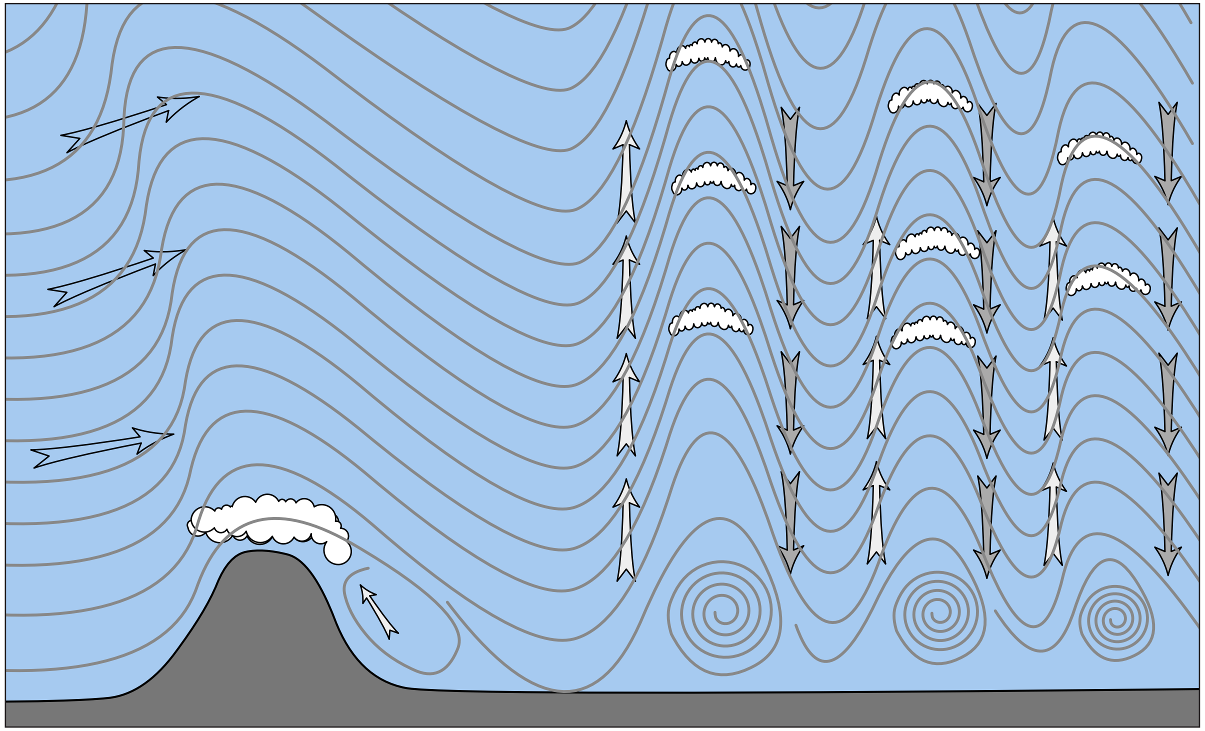
The two gliders explored this strange air for some time trying to understand why in one area there was smooth, strong lift and in another close by, there was violent turbulence.

The flight attracted a lot of attention from fellow glider pilots and from then on, pilots looked for sites where these odd lenticular clouds were found.

Waves form in the atmosphere downwind from mountain ranges in the same way that standing waves form in a river downstream of large rocks. Atmospheric waves also are stationary in that the peaks and troughs of the wave stay more or less in the same place.

There's no doubt that on any day where there's a moderate to strong wind, waves will be generated from hills, ridges and mountains and will influence the lift over a large area. To generate a wave large enough for gliders to soar, the wind strength, direction, vertical profile and the shape of the ground must be right. In the right conditions, atmospheric waves are a reliable source of lift and great height gains can be made.

To form good wave lift, specific meteorological conditions must exist. Obviously you need a mountain range in the way of a reasonably strong wind. The wind needs to hit a range at close to 90 degrees and increase in strength with height. The atmosphere must be otherwise stable. This is important because in stable conditions, the layers or strata of air can slide more easily over each other. When conditions prevail where the atmosphere becomes mixed, for example through thermal activity, this creates friction which slows the wind.



Unlike the shape of a ridge which produces good lift, a mountain range which has a steep slope on both sides seems to form the best waves. Downwind from the ridge, the airflow oscillates and if the conditions are right, the wave height is amplified considerably above what might be expected from the ridge height.

Often, a stationary lens-like or lenticular cloud forms at the top of a wave and these clouds are a reliable indicator of wave conditions. Mountain wave clouds are not stationary but are rapidly forming at their leading edge and dissipating at their training edge as the airstream which causes the clouds rises and cools or descends and warms up. Small changes in wind can cause lenticular clouds to appear or disappear almost instantly.

Like stationary waves in water, mountain waves can form primary, secondary and many other smaller waves downwind. The height of the waves grows with increasing wind energy but like waves in a river, the spacing between waves (wave length) is constant irrespective of the speed of the wind. On a good day in some mountainous regions, it's common to count more than 20 lenticular clouds capping waves and the effects can be felt down wind for more than 100 kilometres.

Soaring waves

The methods of contacting wave lift vary from place to place. You may be able to ridge soar up to a height when you can contact wave or you may even be able to climb using the energy of the rotor.

The wave is stationary but the air which forms it can be moving quite fast, so you may do figure 8 type beats or you may just fly straight ahead, maintaining a more or less stationary position over the ground while you gradually climb. In fact, one clue to knowing you are in wave lift is that you are climbing very smoothly and calmly compared with most other forms of lift.

In Australia, wave lift is mainly used for height gains and there are many winter camps whose sole aim is to let pilots have a crack at a diamond height badge.

Overseas, in some areas such as the Alps, ridge and wave lift can be flown in the same day. In places such as New Zealand and the Andes, distances over 2000 km are possible.

Wave lift can take you very high indeed. The Australian record is over 34,000' and the world record over 75,000' so oxygen is required when wave flying. Demand oxygen systems which are suitable for low altitude flying, are unsuitable for high and extreme altitude, so make sure you get qualified advice and install the right equipment.

Obviously, with such altitudes, it can get cold when wave flying. One side-effect of this is that ice crystals can form on the canopy and parts of some flights are made in a complete white-out. The glider becomes cold soaked and gel coat can get brittle. Superficial gel coat cracking can occur if the glider is caught in the turbulence of a lee rotor.

If you want to know more about wave lift, on a cold winter's day, go to a mountain stream with a diving mask. Find a set of rapids, put your head underwater and you can discover quite a lot about standing waves.

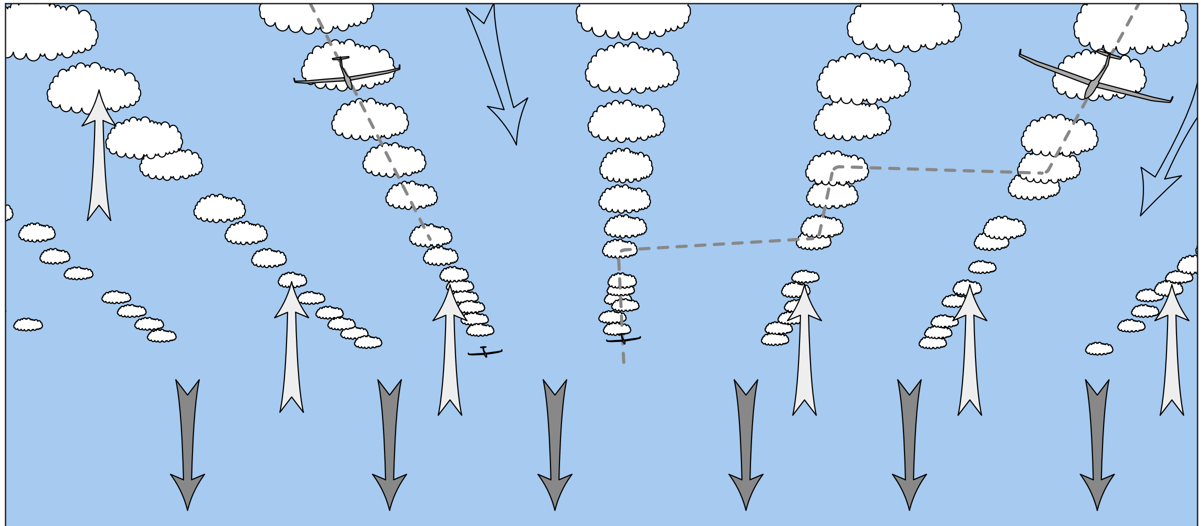
Watching the bubbles, you can see that under the smoothly flowing water, there are places where the water looks more like a big rolling wave on a surf beach. Underneath each atmospheric wave where the air rushes downwards there's often a rotor cloud formed where the air spins around like a washing machine. It can be a bit like flying in a washing machine too and overseas, gliders and other aircraft have been severely damaged or have broken up in wave rotor.

Other Sources of Lift

Though thermal, ridge and wave lift are the main sources of lift, there are others which you as a pilot, may use in almost every flight. These include wave, cloud suck and convergence.

It's useful to understand that wave lift can occur anywhere a ridge or hill meets a prevailing wind and can be a cause of gravity waves in otherwise thermic conditions. Air is a fluid and behaves much like other fluids such as water.

Looking at time-lapse video of clouds forming in mountain ranges, it's easy to see ripples and swell in the atmosphere, just as in the sea. If a ridge is the right distance downwind from another, waves can generate wide areas of rising and sinking air. In thermic conditions, lift can be significantly reinforced. If the wavelength is wrong, lift can be reduced or cancelled.



Cloud streets form aligned with the wind. There's lift under each street and bands of sink between. Gliders can fly for long distances without turning under streets. When the track does not align with the street, it's best to cross at right angles, staying in lift where possible.

Cloud streets and energy lines

Clouds like lining up into what are called cloud streets. Given a little wind and a good day, you will see rows of evenly spaced clouds dotting the sky and arranging themselves in line with the wind into streets of energy. Between the streets, there's normally a band of sinking air. In a glider, you can cruise under the clouds in these streets and fly for hundreds of kilometres at times without turning, slowing occasionally to make the most of the available lift under a strong cloud.

If the cloud streets are not in line with your course, the best strategy is to fly along the streets and then cross at right angles to make sure you fly in sink for the shortest time. Cloud streets will happen on blue days too… there just won't be any clouds to mark the street. Be very aware that this might happen and whenever you fly through a large patch of rising air, try and analyse what might have caused it.

There are two key rules about staying up. In fact, make that one rule. And that is; don't fly in bad air. Certainly, when thermalling, never turn in bad air twice. More importantly, don't fly too long in sink.

If you have a look at the traces of pilots from competition days, you will probably find to your surprise that most pilots on a day spend about the same time in turning flight. It was how they flew between climbs which made the difference.

The ones at the top of the results fly better between climbs. How do you do this?

You will often hear pilots talking about "energy lines". This isn't some new-age hippy theory, it's a fact. There are places where the air mass is sinking and others where it may be rising… or sinking less. This can be caused by geography… If there is a wind, there may be wave lift and the associated sink around, or it may be caused by meteorological conditions.

Whatever the cause, if you fly in areas where the air is more buoyant and is sinking less or even rising, you can fly for a lot longer without needing a thermal. You should always be aware of this and be on the lookout for good air.

Whatever the reason, avoid sink! If you find that you have been flying in sink for a while and it doesn't appear to be related to a thermal nearby, make a turn to one side or another (remembering your lookout) by 45° and look for some air which isn't sinking quite as fast. Then turn back on to your original heading. In light conditions, you may turn a full 90° with advantage if you avoid strong sink.

On windy days, be aware that low ranges well upwind of your position can cause waves which will affect not only thermals but the surrounding sink. If you are being seriously drilled in massive sink, take a moment out from feeling victimised to think about where the sink might be coming from and turn in the opposite direction if it is possible.

Cloud Suck

If you were paying attention at school, you might remember the latent heat of condensation of water. When water changes from vapour and condenses into water droplets in clouds, it releases heat. This has the effect of amplifying or stoking a thermal.

On days where there are tall "Marge Simpson's haircut" type thermals, the extra energy from this condensation may give good lift right under the cloud.

Even on a dull and low energy day, or perhaps especially on a dull and low energy day, there is lift close to cloud base. Enough lift that a glider can float for long distances under dense decks of clouds. To stay up like this, it is often necessary to cruise quite slowly, close to the glider's minimum sink speed, to remain in contact with this cloud suck otherwise if you lose contact you may not get back up again.

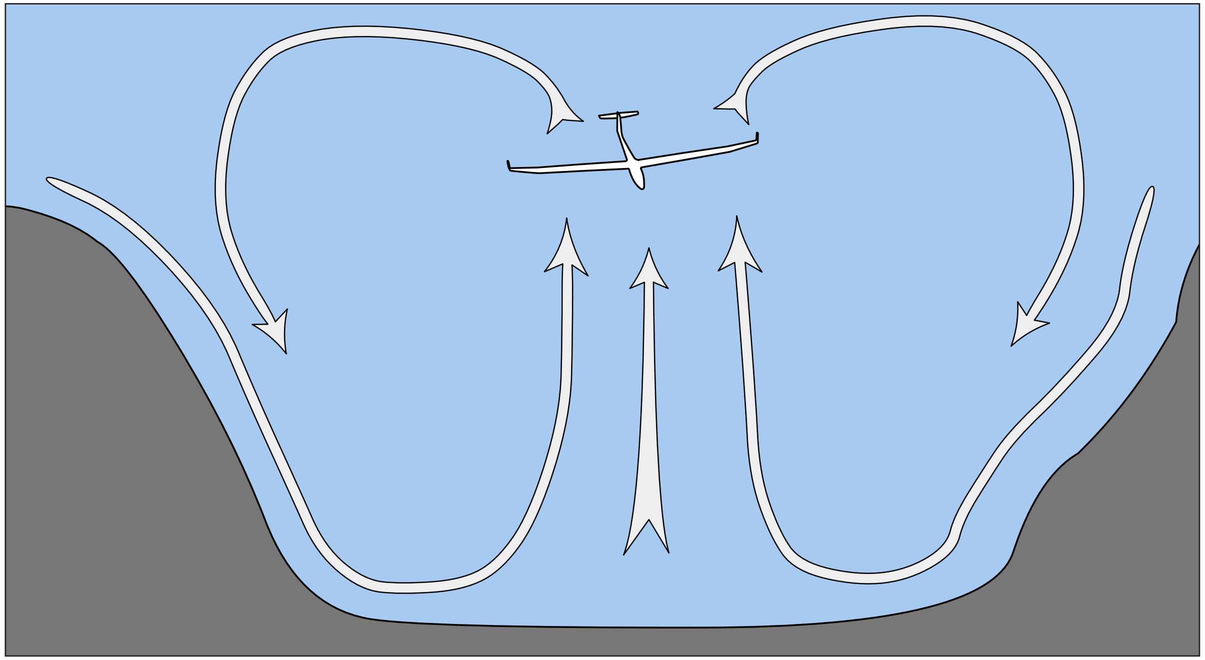
Typically, when conditions are such that the cloud deck overdevelops, it will shut out the sun's rays from the ground and thermals will get weaker. These are often 'get high and stay high' days, when if you can get close to cloud base with a thermal, you can enjoy quietly drifting along without losing height.

Convergence

Convergence occurs when two air masses are pushed together and rise up to cause lift. This might be when a ridge or mountain range has thermals on one side and a wind on the other side and they meet at the crest of the ridge and surge upwards, each reinforcing the other.

Convergence is common when a cold and warm mass of air meet. The colder one will undercut the warmer and push the warm air mass upwards. This can be frontal air or it may be a sea breeze front meeting a warm air mass or offshore wind as it moves inland. Sea breeze fronts are often marked by clouds on the warmer side of the convergence and blue on the cooler side.

Convergence causes buoyant or rising air over a large area and is something to be aware of if you find the vario giving positive readings and circling does not lead anywhere. Look for causes of lift and work out the consequences if you fly into sink areas outside.



Wonder Winds

A particularly nice form of convergence occurs in shaded valleys, normally in the afternoon. As the high ground cools, the air flows downhill as a katabatic wind. This fills the valley and forces the warmer valley air upwards, often over a very wide area.

The result can be a few hours of soaring in silky smooth lift at the end of the day where it can be difficult to see a specific source and even difficult to get down without "coring sink".

There's an opposite to wonder winds which could still be worthy of the name. In this case, a cool katabatic wind descends from higher ground into a valley or flatlands and pushes out the warm air, killing any lift. This effect is quite common on the coast where the sun may have moved westwards and put the high ground into shade hours earlier.

The katabatic flow can be severe enough that gliders are quite suddenly unable to remain in the air and have to land quickly, where ever they can.

Australia's Morning Glory Cloud

The Morning Glory is a cloud unique to the Gulf of Carpentaria in the north of Australia. Morning Glories form around midnight over western side of Cape York around midnight.

They develop along the convergence line between the previous day's west coast sea breeze and the normal South Easterly trade winds. As the sea breeze dies off the Morning Glory forms and starts moving to the west. They generally arrive at Burketown around dawn.

Morning Glories occur around the period of change between the dry season and wet in September, October and November. As the cloud crosses the coast and moves inland, it weakens and dissipates but has been known to travel several hundred kilometres inland.

It's possible to soar the front face of the cloud and the phenomenon has produced some remarkable flights… almost 1,000 km in distance and over 10,000' in altitude with speeds over 100 knots. Morning Glories travel at up to 70 kph and have been seen over 9000' with bases around 500 feet above the ground.

In fact, the cloud may be more than a single roll cloud. It is common for there to be many clouds behind the first and you can jump from the front cloud and soar a secondary and even subsequent ones.

The main centre for catching Morning Glories is Burketown, mainly because there's a good airstrip and accommodation.

Normally, gliders are prepared before dawn and launched at first light into uncommonly smooth air. The gliders then climb over the crocodile infested mud flats towards the sea and if they're lucky, meet a cloud. The lift is typical of wave lift, smooth as silk and in the early dawn light, the experience is unforgettable.

Because of the difficulties of the terrain… mud flats and crocodiles, the Morning Glory is normally flown by self launchers and touring motor gliders. If a glider lands on the mud flats, it would be impossible to retrieve and the pilot might have already become breakfast for a croc.

Many parts of this country present massive retrieval problems in the event of an out landing. In some cases a helicopter with a sling would be the only option.

There may be less than ten well formed Morning Glories each year and in La Nina weather cycles sometimes none at all. In spite of all that, many glider pilots make an annual pilgrimage to Burketown with the hope of flying the Morning Glory.

Navigation

Navigation

If you are going to fly cross-country you need to learn some navigation skills. In fact, you should start learning about navigation and map reading well before you venture cross-country, because under the right conditions, you can get lost well within gliding range of your home strip.

Getting lost is only a small part of it. We really don't want to stray into restricted airspace and become a danger to other airspace users.

GPS has completely changed the way we fly. You can now glance at a single display and read your latitude and longitude, speed over the ground, track, height above the ground, distance to go, distance made good and more.

Brilliant! But you may still be lost. And of course the GPS may stop working because the battery runs flat or there's a fault in the electronics.

You may have a spare battery-operated GPS or a phone with a GPS tucked away in the glider… but what if the satellites stop working? Having personally experienced this three times, twice during invasions or military actions and once during a huge electrical storm when the GPS system didn't show anything useful for hours, it's worth taking GPS failure seriously.

GPS may have changed everything but it hasn't rewritten the rules about basic navigation. In fact, GPS has made learning the basics even more important.

Unlike birds, most humans have no innate ability to navigate in the air but we can learn how to do it. The more aware we are of the environment we're flying in and above, the better our chances are going to be of not getting lost.

On most days when we fly, either the sun will be visible or we'll know where it is. Though the sun moves around a lot, from minute to minute, your angle to the sun is one of the best clues as to which way you are heading.

A lot of the terrain we fly over in Australia is flat but in the same way that we look at the ground for clues as to where thermals might trigger, we should look for significant landmarks to aid our navigation. Like using a bread-crumb trail, we can fly from landmark to landmark, always remembering that when we return, the sun will be lower and we'll be approaching from the opposite side and the landmarks may look quite different.

By watching our drift across the ground when circling, the pattern of wind on water, drifting smoke or the shadows of clouds moving across the landscape, we can get clues as to the wind direction. These elements help us build a mental picture of where we are as we fly. If we rely only on GPS and forget to note all these details, we'll get lost more easily!

Electronic Navigation Aids

As useful as GPS is, the chances are that the GPS you're using is not approved for aviation. Typically, a GPS approved for aviation is about 10 times the cost of those we use in gliding. Most our navigation instruments including the GPS and charts on most glide computers are not approved.

This doesn't mean that unapproved GPS receivers are less accurate. Flarm claims to be many times more accurate to enable collision avoidance. The approved devices just have better integrity and error reporting.

No doubt this situation will change over time since many countries already allow uncertified GPS devices to be used when navigating in light aircraft.

Australia's Civil Aviation Safety Authority allows an approved Electronic Flight Bag (EFB) app and a backup of either an EFB or current approved paper charts can be used as a primary source of in-flight documentation.

The word 'approved' is our problem. Current air legislation recognises that documentation such as charts, diagrams and other required information can be in electronic or paper format. It's the information which is important, not the media. But legally, it has to be approved.

Approved charts can only be published by a small handful of authorised providers and the electronic charts in our glide computers are almost certainly not from these suppliers. Nor is the Caltex road map from the local servo station… if they still sell them. '

Tablets and phones are classified as COTS PEDs (Don't they love their acronyms?) or Commercial Off The Shelf Personal Electronic Devices. Their GPS functionality doesn't meet aviation standards and these devices can't be used as a primary means of navigation. To meet regulations, even the mount has to be approved.

There are several approved EFB apps which run on tablets like an iPad which include all the necessary charts and documentation. Have you tried to fit an iPad in a single seater cockpit? Even the small sized iPads almost completely fill a glider's cockpit and get in the way of proper control and navigation.

What about a phone? CASA says that the minimum recommended screen diagonal is 200mm so charts are displayed at a resolution similar to paper versions. Possibly the newest, largest phones with a high resolution display might meet the spirit of the recommendation in terms of legibility but would probably fail in terms of the amount of scrolling required.

What this means is that glider pilots are currently trapped between a rock and a hard place. Most of the practical electronic navigation aids we use are unapproved but a typical leather pilot's flight bag will not fit, even in a large two seater's cockpit. Just the En Route Supplement (ERSA) is the size of a brick.

Before getting into some practical suggestions, it's worth giving a little more thought to the limitations of COTS PEDs.

Phones and tablets are battery powered devices and they don't rely on your glider's power supply. This is on the whole a good thing but because phones and tablets are designed for the average consumer, they have a hard time being visible in the sunlight of a glider's cockpit.

To make the screen sunlight visible, these devices use a lot of power and if they're run continually, they get hot and the internal battery runs flat very quickly.

A glide computer gets hot too… almost too hot to touch on a sunny day but these are designed for the high temperatures of a glider's cockpit.

Phones and iPads are not. In fact, they're designed for operation between -20 to 34° C and if left in a hot cockpit the screen will go black and they will shut down until they're cooler… which can take some time.

While you're legally OK to use another iPad as a backup, if the primary one is too hot, then the backup one may be as well. And the nature of backup devices is that the battery will be flat.

What this means is that we should all fly with *current* charts and use our GPS, glide computers and EFBs to update our position on the chart. We should not rely on unapproved electronic navigation aids as primary in-flight tools.

It’s important to understand your rights and privileges as a pilot. We’re using the same airspace and sometimes, landing at the same aerodromes as aeroplanes carrying passengers. None of us want to unwittingly fly into controlled airspace especially not if the airspace contains solid objects. So obviously, we should take our responsibilities very seriously and abide by the rules.

This means learning navigation by more traditional methods is essential. If you are flying anywhere near controlled airspace, you must make sure that your paper charts are up to date and that you’ve been properly briefed on NOTAMS and any recent changes to airspace.

Most information including charts other than things like World Aeronautical Charts can be downloaded free from Air Services Australia so it’s neither difficult nor expensive to comply.

WAC or World Aeronautical Charts, which are very useful for gliding can be bought, downloaded and printed out, remembering always to check currency before using any chart.

Please bear all this in mind when reading the following information about glider computers, GPS and moving map displays!

The Magnetic Compass

Most gliders are fitted with a magnetic compass. It's legal requirement in Australia to have a compass fitted, though it's probable that few pilots who have a GPS regularly use a magnetic compass. For a start, most compasses in gliders are too small and poorly damped to be of much use when steering a course. Secondly, unless you are lucky, the North your compass points towards is not the same as the North on your map.

The reason for this is that the lines of magnetism covering the earth don't start and stop at the geographic North and South poles and these lines themselves are anything but straight. This is called Magnetic Variation… the difference between true North and the north as shown on a compass. Across Australia, Magnetic North varies by as much as 12º from true North and in other parts of the world by as much as 30º.

Another reason for mistrusting a compass is that unless it has been checked and compensated, a compass may have errors due to internal and external influences. This is called Magnetic Deviation. A magnetised screw or a poorly shielded electronic instrument near a compass can cause large and possibly intermittent errors.

You might wonder how the navigators of old got anywhere without getting lost. The answer is of course that they travelled very slowly and many were lost a lot of the time.

Navigating by chart and compass alone is fine for a boat at 7 knots but is difficult in the tiny cockpit of a glider at 70 knots. GPS has revolutionised navigation for good reasons… it's easy to use and it works very well. In modern gliding, using GPS for navigation is almost essential. Though a chart and a compass are your primary navigation tools, GPS is a great deal faster and easier.

Although GPS units can be set to read true or magnetic north, most are set to read true North. That is, when the GPS indicates you are tracking North, it's the same as North shown on the chart. Unless you are flying in a region with 0º magnetic variation, there will be always be a difference between the bearing shown on the compass and the one on your GPS.

You need to be aware of the value of Magnetic Variation for your region but you have probably got better things to do than be constantly calculating the difference when flying. It's easier to use the GPS and true North as shown on your chart for headings.

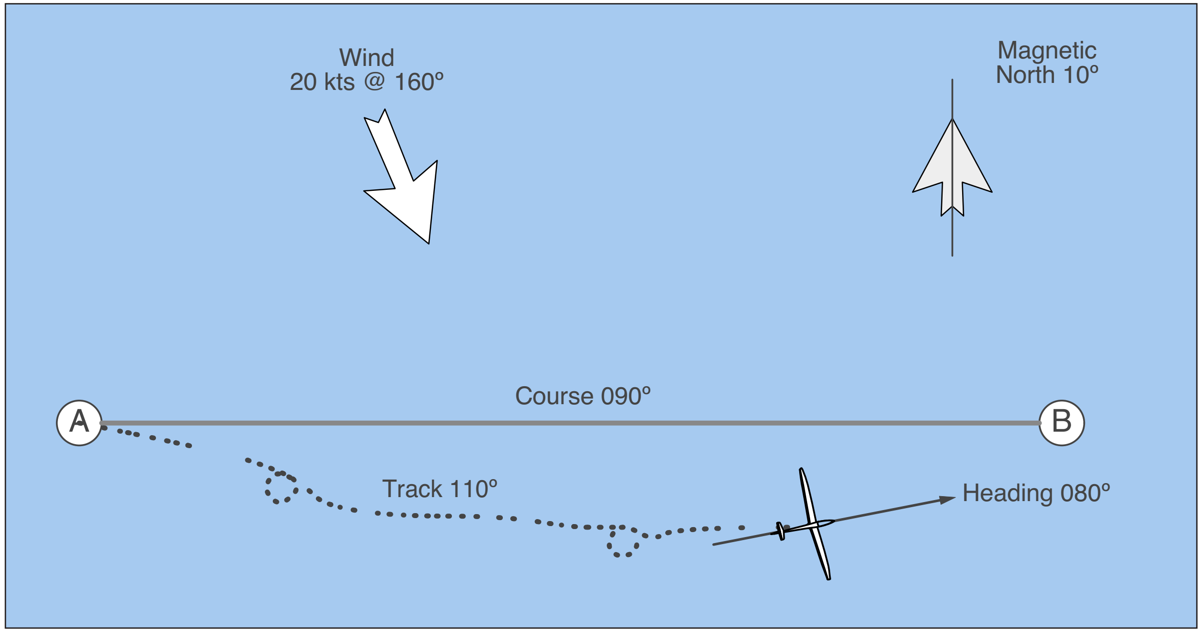
Flying from A to B.

At some time, you're going to want to fly to somewhere far enough away that you can't see it. You can get the distance and bearing from a chart or by entering its waypoint on a GPS or glide computer. Many experienced navigators draw their course on a map, either in pencil or with a removable felt tip on a plastic laminated map before launching.

The *Bearing* tells you the *Course* you have to fly to get to your waypoint and if there's zero wind (which is hardly ever) and you fly accurately, your glider's *Track*, or the course made good is will be the same as the line on the chart.

Since there's almost always some wind, and you'll drift while cruising and circling, your *Heading,* or the direction in which the glider is pointing is hardly ever the bearing you read off the chart. You will need to offset your heading to compensate for the drift due to the wind and any excursions when thermalling.

If you have to fly on a set heading, you need to continue keeping a good lookout when in cruise between thermals and not spend too much time looking at your instruments.



In any case, steering to a compass heading is quite difficult, so pick a distant landmark which is close to the right bearing shown on the cart or GPS and keep the glider tracking more or less at that until you are close enough to pick another landmark further away.

It doesn't matter if the point you pick is not exactly on the right track. Most pilots can't fly that accurately and you'll almost certainly have to correct for drift due to the wind. At least you will be looking out of the window rather than staring into the cockpit.

As you get close to one chosen landmark, pick another one further along your course and head for that.

Charts

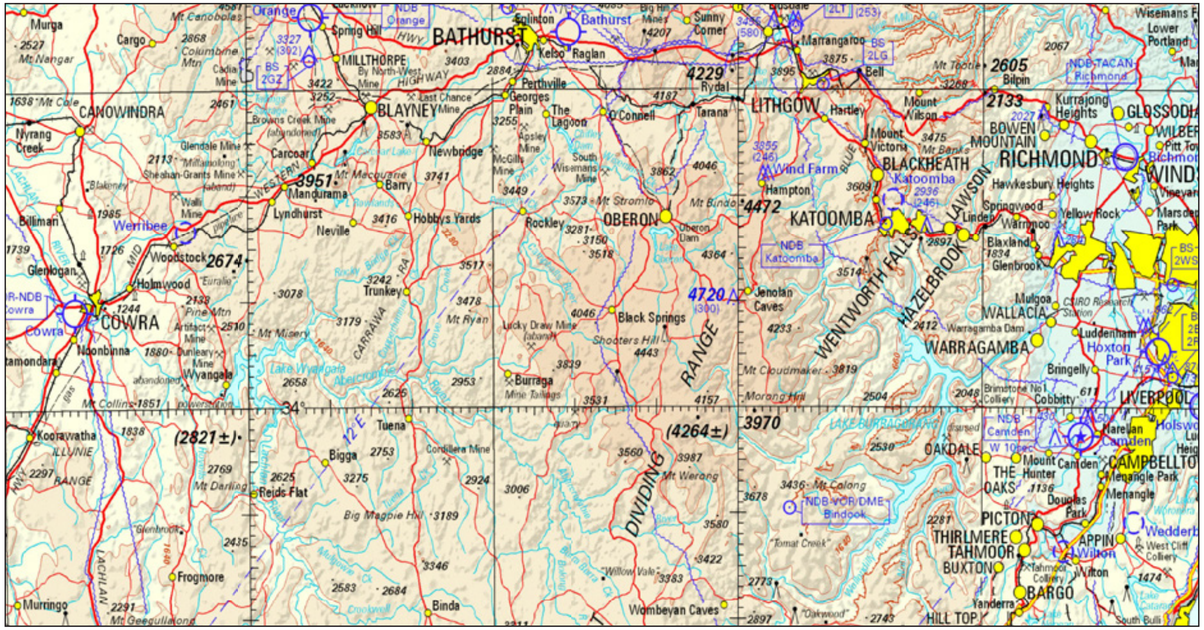
When flying gliders cross-country, we have a few differences compared to powered aircraft. We're going to spend a significant percentage of our time circling and if there's any wind at all, we will drift downwind with the thermal when circling.

Gliders are quite capable of flying cross country at well over 100 kph average speed. Combine that with the fact that we generally fly from thermal to thermal rather than in straight lines, and you can see that navigating in a glider is an interesting challenge.

In-flight navigation is done with a combination of instruments like compass, paper charts, GPS and our mental map, most of which needs to be prepared in advance.

Strictly speaking, what we use for navigating are called charts not maps and the most commonly used charts for flying in Australia are sections of the World Aeronautical Chart or WAC and Visual Navigation Charts or VNC.

Unlike many other countries with active aviation, almost all Australia's population centres are close to the coast and the inland areas, though great for gliding, are not that interesting to most aviation cartographers.



What this means is that for flights under Visual Flight Rules (VFR) the detailed aviation charts are coastal. If you want VFR charts of the inland, they're probably going to be WAC or VNC charts.

WAC charts look a little like a conventional road map in that they show larger towns, roads, aerodromes, rivers and contours but importantly, they don't show airspace or many of the smaller strips used by gliders, sports and General Aviation (GA) aircraft..

While WAC are not exactly the world on a single sheet, you only need about two for each state in Australia. The scale of 1:1,000,000 (that's one millimetre on the chart to one kilometre on the ground) is small but useful for planning and en-route purposes

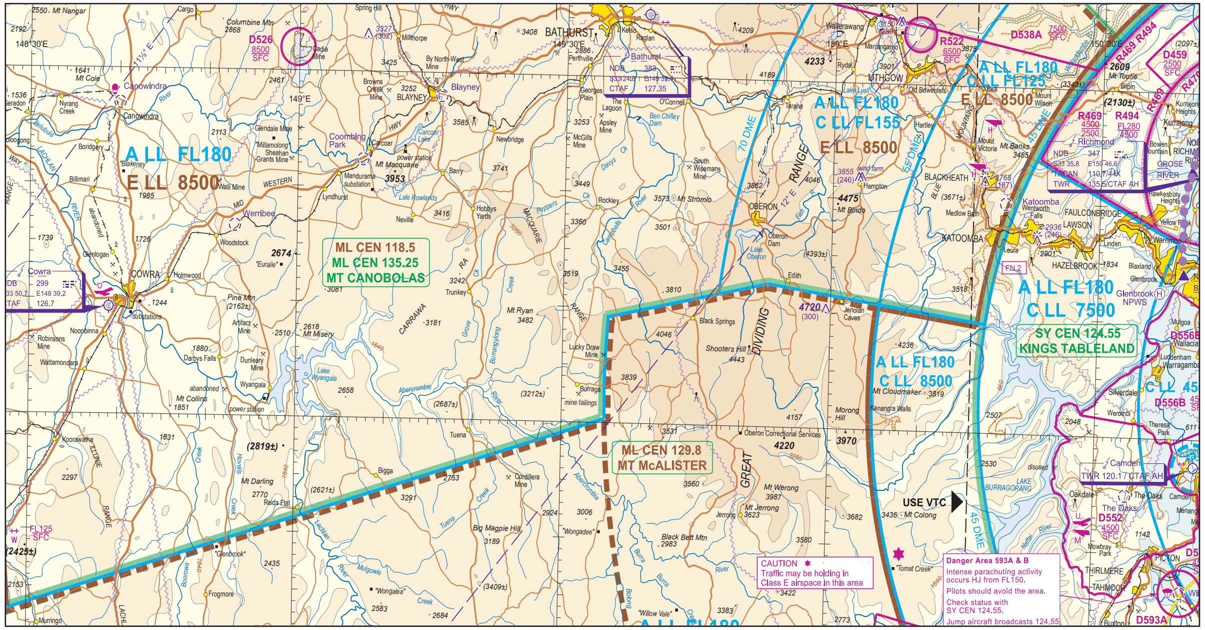
WAC charts are available in electronic (pdf) and paper format but at this moment, they all have to be bought. These charts have a reasonably long life span and at the time of writing, most of the downloadable charts were published at least two years earlier.

Printing charts

If you download charts in digital format, you can print sections to the size you need. All charts get out of date due to changes in airspace etc. and need to be renewed before they expire, but the cost of printing your own digital maps should be well below the cost of buying the paper version.

If digital maps is the way you decide to go, tough waterproof plastic paper is available which is perfect for charts. If you print on ordinary paper, you run the risk of having your maps decompose in flight when you have a leak from a water bottle (and you will have a leak!)

Electronic Flight Bag apps have printing features and as long as the app and databases are kept up to date, you can be sure that the printouts are current (at least at the moment you press print). The printout is great for things like runway diagrams but it doesn't seem to be great for printing large areas of WAC or VNC because the print resolution is only adequate and no substitute for the higher resolution downloaded charts.



Visual Navigation Charts (VNC) are another useful chart for VFR and glider flights. VNC are made to a scale of 1:500,000 (2 millimetres on the chart to one kilometre on the ground) which is perhaps a more useful scale than WAC.

Unlike WAC, VNC show airspace. Because of that, they're updated much more frequently than WAC. VNC can either be downloaded in pdf format free from the Airservices Australia website's Aeronautical Information Package (AIP) area or a print version can be bought through the same website.

At first glance, VNC are ideal for gliding but there's a catch. About 14 charts cover Adelaide, Tasmania, Darwin, Perth and a strip of the eastern seaboard from Cairns to Melbourne but they don't cover a large amount of the inland where most gliding takes place.

For example, the area around Bathurst gliding club is shown here on both WAC and VNC. The WAC shows another 200km north while the VNC stops exactly at the top of the view here.

The airspace around Sydney is shown well but if you were to fly from Bathurst to the Hunter Valley or Central coast, you'd need the Newcastle VNC as well as the Sydney VNC because Sydney airspace overlaps the two.

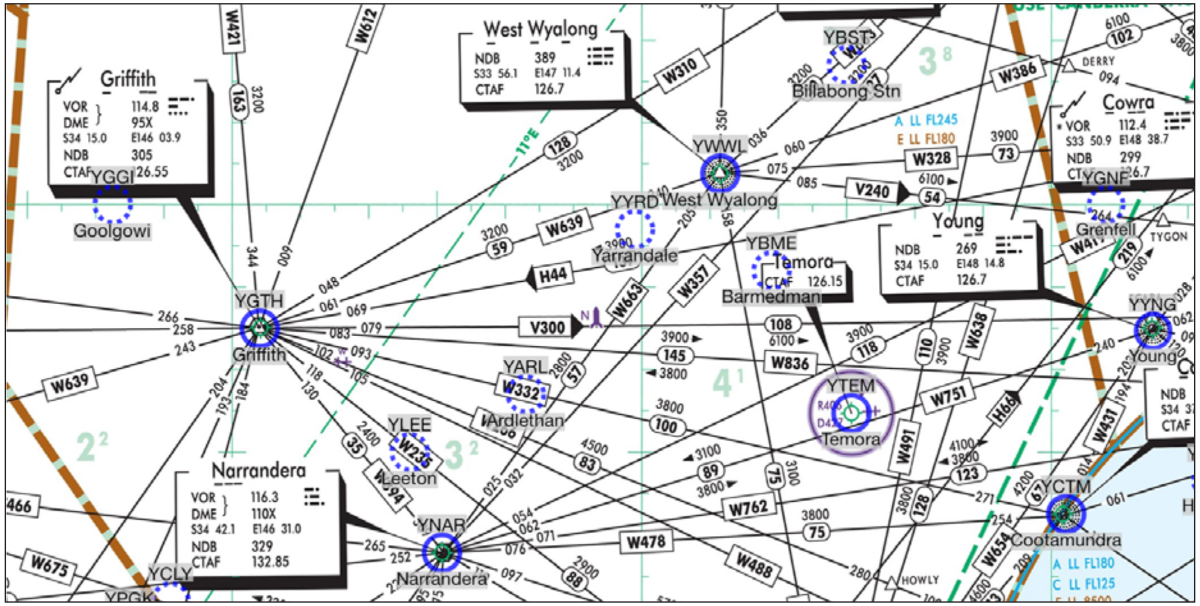
What this means is that you'll do most large scale planning on a WAC and move to the VNC for airspace coverage around larger towns.

There are other charts which should be used when planning cross-country flights like En-Route Charts (ERC) and Visual Terminal Charts (VTC). Both these chart types are updated frequently and can be downloaded from the Airservices Australia website's Aeronautical Information Package area.

ERC-LOW charts show the general relationship between significant towns and airports with area radio frequencies etc. but have little in the way of topographical and terrain information so they may be very suitable for navigation in straight lines but are not so useful for gliding.

On ERC, VTC and VNC the most important information is Controlled Airspace, Restricted and Danger Areas.

Sports, GA Light aircraft and regular passenger transport aircraft use ERC charts extensively.



If you look at a section of an ERC outside major cities, you can see radial lines between country towns and it's these air routes which power aircraft commonly (but not always) use for navigation.

If you are close to a country town or common air routes, keep a good lookout for power aircraft and monitor the local Common Traffic Advisory Frequency (CTAF). As you can see in the picture above, the CTAF can change from aerodrome to aerodrome and may also be changed over time so check and stay current!

CTAF is the normal pilot to pilot frequency used in the vicinity of an aerodrome without a control tower, both for VFR and Instrument Flight Rules (IFR) aeroplanes. Switch to the local CTAF frequency when about 10 nautical miles away.

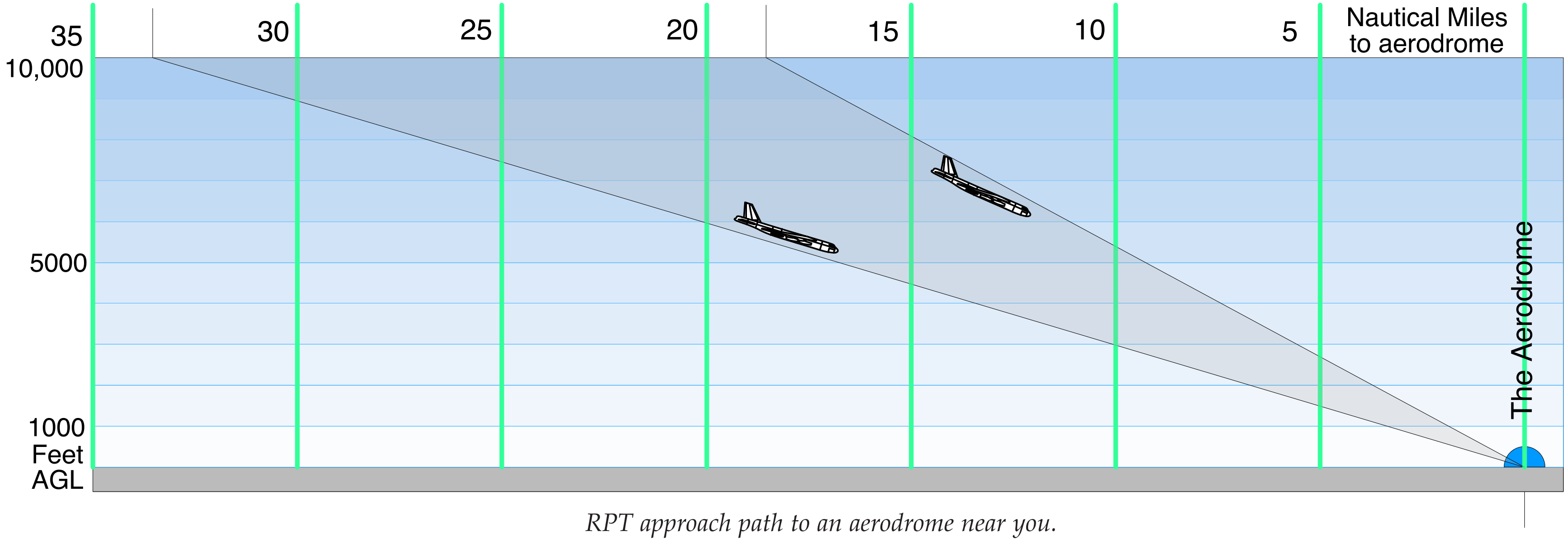
If you are flying in the vicinity of any reasonable sized country town, you should expect Regular Passenger Transport (RPT) aircraft to be landing at the aerodrome as well as smaller GA traffic so it's essential to practice proper radio communications.

Pilots of other aircraft appreciate knowing where you are so don't be afraid to broadcast if you think there might be a chance of being close to them.

If you hear air traffic in the vicinity and especially if you intend landing at that aerodrome, broadcast your position… your distance in nautical miles and direction from the aerodrome, your current altitude and intentions. Make sure you include the fact that you're flying a glider in case other traffic thinks you're just doing a touch and go.

It can be difficult at first to get an understanding of all the different traffic which use aerodromes from RPT to sports and general aviation aircraft so if you are flying further afield, get advice from other pilots and never be afraid to use the radio. The bigger the aeroplane, the more professional and helpful the pilot is likely to be in terms of radio communication.

Most sports and general aviation aircraft will approach and fly a circuit around an aerodrome in much the same way as a glider so they're easier to understand and locate with best "alerted see and avoid" practice.



RPT approach path to an aerodrome near you.

RPT traffic is more difficult to look out for because they fly much faster and often make straight-in approaches. High performance turbine aircraft will descend through 10,000' between 20 - 36 nautical miles away from an aerodrome at 230 - 250 knots.

RPT traffic may approach the circuit at about 200 knots and either overfly at 2,000' AGL or manoeuvre for a straight in approach, being established on final by 5 nautical miles.

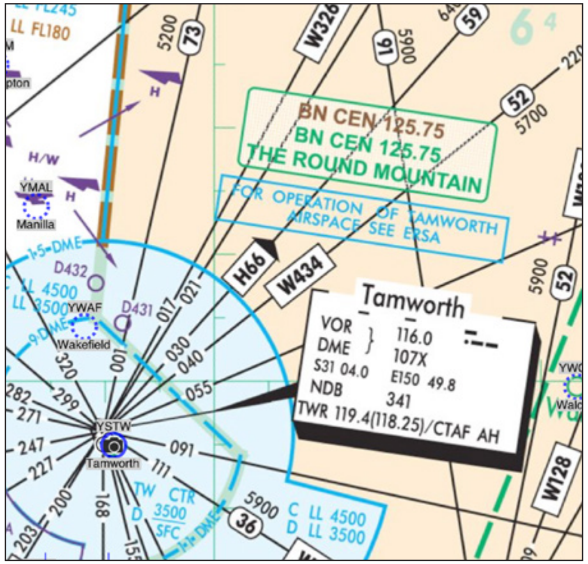
When manoeuvring for an instrument approach (which may happen in either visual or instrument conditions), RPT aircraft will normally be limited to a 10 mile radius of the aerodrome and they will rarely monitor glider frequencies. Therefore always monitor the CTAF frequency within 10 miles and below 3500' of an aerodrome being used by RPT. Monitor the ATC frequency at other times.

Never be afraid to communicate safety information with other traffic. In the words of one Qantas pilot: "*I can understand how hesitant [glider pilots] may be, talking to a big jet but we're honestly more than happy to have a chat with them using plain English than have them feel intimidated, clam up and be invisible!*"

Automatic Terminal Information Service (ATIS)

ATIS is a continuous broadcast of a recorded message that states runways in use, NOTAMS, meteorological conditions, and other operational information for air traffic controlled aerodromes. You can listen to this information by tuning to the appropriate frequency.

ATIS broadcasts are regularly updated and each version is assigned a letter from 'Alpha' to 'Yankee' so a pilot can quickly confirm that they have the current information. In Australia, 'Zulu' is reserved for when the control zone is deactivated and CTAF procedures apply.



Air Traffic Services & Air Traffic Control.

Glider pilots are entitled airspace users with not only a legal but a common sense/self preservation requirement to avoid collision. We are not just encouraged but duty bound to make any radio calls necessary to achieve that end. Air Traffic Control (ATC) and Air Traffic Services (ATS) are there to help.

Any EnRoute Chart (ERC), Visual Navigation Chart (VNC) or Visual Terminal Chart (VTC) will provide the relevant ATC frequency for your area of operation. If you have trouble getting hold of a chart, use software such as OzRunways to print out of the section you need.

When communicating with ATS or ATC, use their name in place of their call sign. In the section of the ERC alongside, Tamworth ATC and Brisbane Centre ATS are shown with their respective frequencies. Brisbane centre covers a large area of the east coast whereas Tamworth handles local traffic.

Tamworth is typical of a regional airport in that it has a manned tower some of the time and reverts to a CTAF outside tower hours. The relevant frequencies are below the ATC name; 119.4 is the Tamworth Tower frequency, as well as the CTAF frequency after hours when the tower is not active. The geographic location of the transmitter (for information only) is sometimes listed below the ATC or ATS name.

You can give yourself as traffic on an ATC frequency, to the controller or directly to the inbound aircraft, request known traffic inbound to your location and get an updated QNH.

Many regional gliding clubs fly in or close to controlled airspace and it's possible to enter this airspace after getting an airways clearance, particularly if local RPT traffic is light. Some regional airports have only a handful of flights each day. An example of where you might want to glide in controlled airspace is the Melville Ranges near Tamworth. In the afternoon, the ranges often seem to have better conditions than the plains to the west.

Lets say that it's a 9,000' day but it's getting scratchy and you want to head north along the clouds over the Melville ranges instead of the plains. Before heading into airspace, you must contact Tamworth ATC.

A request for an airways clearance will take the general format of:

- Who you are asking for a clearance.
- Who you are.
- Your position.
- Your altitude.
- Your desired track.
- Your desired altitude.
- Request Clearance.

ATC will reply using a set format and you will need to read back some sections to ATC so they understand that you have got the message clearly. So before calling ATC, be ready to write down their reply. The ATC response can include either a clearance, a conditional clearance or a requirement to remain outside controlled airspace. When under the control of ATC you are required to converse only with ATC unless in an emergency.

The items which must be read back to ATC include:

- Route clearances in their entirety
- Altitudes
- Headings or speeds
- Direction of turn

When reading back, you must add your glider's call sign to the end of the transmission.

If you are flying at a time when the Tamworth ATC is active, the radio procedure to contact the tower and request clearance to overfly the Melville ranges goes like this:

First, tune into Tamworth Automatic Terminal Information Service (ATIS) and listen to the broadcast, noting QNH and setting this on your altimeter subscale. You need to be confident of your altitude when talking to ATC and other aircraft.

Then tune into Tamworth tower frequency and request a clearance. It's a 9,000' day so to remain clear of clouds, ask for a clearance to 7,500'.

You: "Good afternoon Tamworth Tower
This is glider Alpha Bravo Charlie,
4 miles south Lake Keepit, 5,500',
Tracking Keepit – Currabubula – Werris Creek via the Melville Ranges,
Not above 7500',
Received Alpha (the ATIS information), Request Clearance."

Following your clearance request, you could expect to receive an airways clearance such as the one listed below. Alternatively, the phrase "Remain outside controlled airspace" may be used to state that a clearance is not presently available. This should be followed by a reason and/or estimated delay before a clearance is expected to be available.

ATC: "Alpha Bravo Charlie, Tamworth tower. Track Keepit - Currabubula – Werris Creek via the Melville Ranges, remaining west of the railway line, Not above 7500'. Report Currabubula"

Before turning towards those great looking clouds, acknowledge by reading back the clearance

You: "Track Keepit – Currabubula – Werris Creek via the Melville Ranges, remaining west of the railway line. Not above 7,500' Alpha Bravo Charlie"

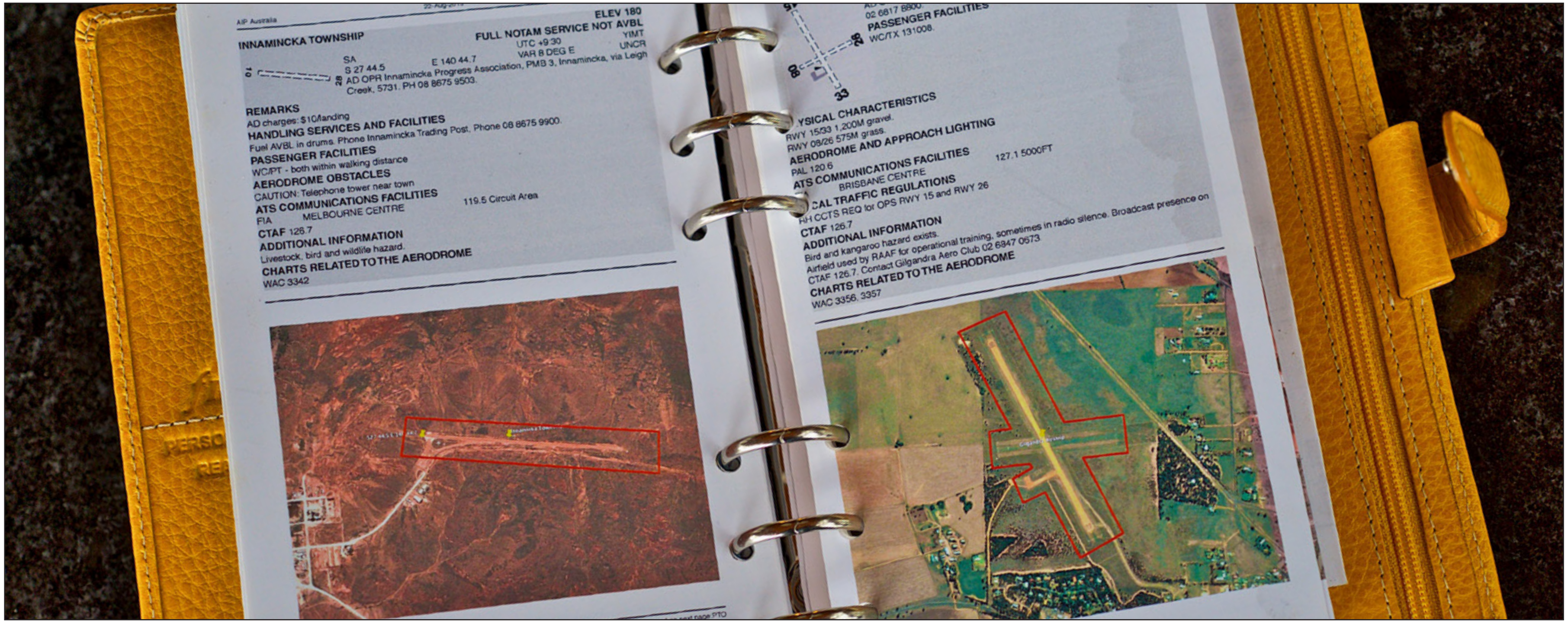
Within controlled airspace, gliders must be flown within 5 nautical miles of the nominal track.

Once you have left the controlled area, there are no further requirements with ATC. When you have left controlled airspace, you may vary track and altitude at will. There is no need to continue to Werris Creek if you no longer want to, once outside controlled airspace. However, you cannot re-enter controlled airspace without first obtaining a new clearance.

ATC is there to ensure you and every other airspace user remains safe. If your radio has a frequency monitor function, set it to listen out on the area frequency.

From an ATC perspective, crossing areas without proceeding directly to or from an aerodrome or navigation aid is a huge workload that does not give the Procedural Tower controller many tools to work with. If the glider is in Class C airspace it must be separated from IFR aircraft and ATC must prevent collisions with other VFR aircraft so don't be surprised if you don't always get a clearance.

Although standardised phraseology has evolved for efficient and unambiguous communication, the need for understanding trumps all else. So if you need to speak plain English, do so!



En-Route Supplement Australia

The En-Route Supplement Australia, or as it's always know, ERSA book is a solid and useful tome containing information on every runway, airstrip and authorised landing area in Australia.

This information includes essentials like runway direction and length, elevation and CTAF frequency as well as the bearing and distance to the nearest town. Because it has so much more than just information about major airports, ERSA is a very useful resource for cross-country flying. The printed copy of ERSA is a bit too big to fit easily in a glider's cockpit and if you're flying around Temora, you probably don't need to know about the airstrip in Broome.

ERSA information is available on-line and aerodrome information can be downloaded and printed out. If you are planning on flying a long cross-country, you can print out the information from ERSA at a suitable size for your cockpit.

The contents of ERSA are also available in EFB format with the advantage that the information should be always current (it isn't actually to take care!) and is at your fingertips. To bring up the ERSA entry of the airstrip closest to where you are is a matter of a few taps on the screen. While it can be argued that even the largest phone screen is too small for reading a WAC, it's quite adequate for reading ERSA entries.

NOTAM

A Notice to Airmen (NOTAM) is used to alert pilots of potential hazards along a flight route or at a location that could affect the safety of the flight.

NOTAMs contain information concerning the establishment, conditions or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel and systems concerned with flight operations.

NOTAMs contain a lot of essential information for cross-country flying and it's essential to check for NOTAMs while planning a route or if you have to divert to an airstrip, perhaps because of weather or an outlanding.

You can view NOTAMS in several ways. The first would be through NIS. This is Air Services Australia's (ASA) pilot briefing website, the National Aeronautical Information Processing Service (NAIPS) Internet Service. The acronym now becomes NIS since it's marginally easier than NAIPSIS. You can also get ASA's AIP (charts etc.) through the NAIPS website (NIS).

A login is required to get pilot briefing notes such as NOTAMS. The login is easy to get through the site itself. You don't need a login for the AIP section where you download charts.

A much easier method of viewing NOTAMS is through EFBs like Ozrunways where a couple of taps on a chart on the screen will pop up local aerodrome information. Another tap on an aerodrome in the list will give you information such as local weather, a Terminal Area Forecast (TAF) and NOTAMs.

Typical NOTAMS contain information such as:

- Restricted airspace has been established around an aerodrome at a specific date and time for an airshow.
- A runway is currently unserviceable, perhaps due to maintenance or decay.
- Airport equipment, such as an Aerodrome Frequency Response Unit (AFRU) is not working.
- The aerodrome's CTAF has changed.

While the AFRU NOTAM may not affect you (unless you were a military pilot arriving for an AFRU (Advanced Flying Refresher Unit)), the other NOTAMS are obviously very important to know in advance.

Just because there's nothing in a NOTAM about an aerodrome doesn't mean you don't have to take a good look before landing anywhere, arriving with enough height to give you time to do this.

Examples of things not on NOTAMs can run from emus and equipment on the strip to strips in poor condition or even fences put up on cross strips, factors which may be local knowledge but which haven't yet been passed on to NAIPS to get a NOTAM issued.

Waypoints

Waypoints are data files which describe navigational points of interest. These may be just turnpoints used in tasks or competitions without any distinguishing landmark or they can be towns, airports, airstrips, radio towers and geographical features like mountain tops.

There are rather too many different waypoint file formats used in GPS devices but gliding software like SeeYou can convert one format to another. Collections of gliding waypoint files can be downloaded from all sorts of places on the internet and most clubs keep a database of local waypoints used for their own tasks and competitions.

A single waypoint entry may just record an abbreviated name for the waypoint along with the latitude and longitude or it may have more information like the full name, elevation, length and orientation of a runway and even photographs or graphics showing runways and airport layout.

With increasingly powerful navigation computers, try to use waypoints with the most information… and always assume that it may be all wrong. If you are flying to a waypoint, check its position on a chart. Many waypoints are typed in by hand and may have been entered wrongly especially the uncommon ones. A mistake entering a degree of longitude could result in an error of 60 miles so always double check before getting lost.

If you are flying with an EFB, they're very useful for cross checking with on a glider computer. For example, flying in a remote area where the next waypoint is a hundred or more kilometres away can get a little exciting because it may be an hour or more before you can see any landmark to check against your chart. With few taps on an EFB screen, you can get a confirmation of the bearing and distance to your next waypoint which reduces the stress level enormously.

With the increasing availability of computer based maps with satellite overlays, you can also cross check important waypoints to make sure their coordinates do line up with the real waypoint.

Some gliding computers and software allow a picture to be attached to a waypoint. If you are planning a remote task, adding pictures to waypoints such as airstrips can be a great help though if the location is really remote, there may not be many alternatives!

Electronic Flight Bags

You have probably seen airline pilots, weighed down with gold braid on their epaulets, carrying massive bags into the cockpit… well, they used to do that. In many cases the contents of the bags have been replaced by an electronic form, the so-called Electronic Flight Bag or EFB.

If you are flying any more than a few kilometres from your home strip, it's worth looking at EFB software. There are versions which run on almost all the popular tablets and mobile phones and for private pilots, the cost is much lower than buying a chart or two.

EFB software has seamless WAC charts of good resolution. You can zoom into a chart to see detail which would be hard to see on the paper version. More importantly, you can see the position of your aircraft superimposed over the chart and a display of speed and heading.

EFBs have the complete contents of ERSA, the En-Route Supplement, Australia. ERSA contains a mass of information about aerodromes, radio frequencies, navigation aids, procedures and facilities. A tap or two on a moving WAC chart will pop up a list of nearby aerodromes with their bearing and distance and radio frequencies.

This is of immense use when flying cross country and passing over numerous towns and airstrips where often, the radio frequency varies with every one.

There's nothing as reassuring as getting confirmation from the EFB that you're where you thought you'd be and the remote strip you are flying to is where you expect.

If you have an EFB on a phone, consider how you power the phone in flight or a get a backup battery for the phone.

You cannot rely on electronics 100% and as discussed earlier, you cannot use an EFB GPS as a primary source of position information. EFB is a great backup to a set of charts.

Moving Map Displays

A GPS with a colour moving map display is an excellent aid to navigation… provided the electricity doesn't run out. Screen brightness needs to be very high to be properly useful in a glider cockpit and bright screens use energy. The displays on these devices are seldom very big and even though you can zoom in and out, you never get a good overview as you can from a chart.

But for everything else, a moving map display works very well and has to be the best available option. Airspace can be overlaid over terrain maps with hundreds or thousands of waypoints permanently stored in the GPS so there's little chance of flying into restricted airspace or getting lost. That being said, you should always have a chart and compass and know how to use them.

Navigation and mapping software for computers

There's a wide range of computer software around for working with electronic maps. Some of these programs are flight planning and analysis software intended for use by glider pilots and others are general purpose mapping and GPS programs. Most of these programs can import waypoint information and overlay it on standard charts so your print-outs are perhaps of more use to you that either plain WAC or road maps.

Whatever your choice, you mustn't fly without some chart in your cockpit showing the area where you are flying. Get used to viewing and handling a chart in the confined space of a glider cockpit so that when you need it, you know what to do.

Route Planning

Even if you do most task and route planning on a computer, it's a good idea to have a backup on paper. Because gliding is very weather influenced, plans, tasks and destinations can change at the last minute on the ground and in the air so you need to get used to working on a paper chart.

Draw out your planned course from the start point through the various waypoints to the destination. These lines form your track. Note the bearing and distance of each leg. Experienced pilots will estimate how long each leg will take and mark off where they expect to be each hour.

Making educated guesses is a very important skill in navigation. You should always begin with a good idea of the answer you expect before you ask a question and based on that, work out what's happened to cause the difference, if any.

For example: You are flying towards a waypoint using bearings on landmarks you have picked ahead of you. You have estimated your speed over the ground and note a feature on the chart such as a town, road crossing or lake where you think you should be. You then look out at the ground and try and identify this feature to fix your position.

If you are not where you expected to be (and you should be close) ask yourself what might have happened to cause the difference. The chances are that there's drift due to wind and your speed and track is not what you expected.

If you keep up this routine, you are unlikely to get lost because you have a good mental image of the chart, your course, where you are over the ground and factors such as wind and drift.

If there's any wind blowing, you will be blown off track and you will need to compensate for this by flying at a slightly different heading so your course made good or track made good is in the direction you want it to be.

This is done with a simple vector triangle where speeds are represented by lines whose length represents a velocity and whose direction represents the bearing.

What to do when you get lost.

As usual, the answer is "Don't Panic!" It won't help at all. We all have been lost at some time and the majority of us got back to talk about it. In most cases, you discover where you are well before things get critical. In any case, don't forget the command, "Aviate, navigate, communicate." Your first task is to fly the plane.

With the increasing reliance on electronics, one of the quickest ways to get lost is to run out of electricity and lose your instruments, especially on a long flight. If the batteries on the gliders you fly go flat regularly, then either change them or make sure your GPS runs off its own batteries and they are fully charged before you fly. If you know your batteries are likely to go flat, mark your last position regularly on a map.

If you are using a GPS without a moving map, set it to a known waypoint and check the bearing and distance to that point. Now look around for some feature on the ground which will correspond to something on your map.

If you have a working radio, tell someone you are lost. Explain your position with reference to landmarks… "I'm 5 km to the East of a long narrow dam between two high ridges bearing 240° to me."

Find a place to make a safe landing. No doubt, if you are flying cross-country and below 3,000', you will have a good one picked already. If you are reasonably high, you may have a while to get yourself sorted out and find out where you are.

If it is late in the afternoon, be aware that it might take so long to get down to circuit height that the sun may have set on the ground and make landing difficult. So if you are properly lost, abandon your task and start planning a good landing. When you are on the ground you can find someone to share the joke.

If you have a GPS in your mobile phone there are some excellent programs intended for air navigation. It's recommended that you only use these as a backup and then only briefly. The main reason for this is that you phone is going to be useless to call for help on the ground if the batteries are flat.

The most important thing is to practise navigating. Even if you are not flying out of sight of your home strip, use every flight as an opportunity to practise your skills so you feel comfortable in this ancient art.

You and Gliding

Gliding is an activity which combines both mental and physical fitness. Maybe you don't need to have the physical fitness of a Tour de France rider, but you do need to look after your body… because if you don't, it can affect your mental state and that can be very dangerous.

Gliding is an unusual sport. Many of us sit almost motionless for hours and hours in a glider cockpit with a heart rate similar to that we'd have sitting in front of the TV or in bed. Apart from neck, hand and foot movements, we are unable to move, strapped tight into our glider cockpits. And while we are not using much in the way of muscle power or asking for much in the way of cardiovascular fitness, we are asking our brains to be awake and alert over a long time.

Water and dehydration

Probably the biggest risk to your mental state is dehydration. A small degree of dehydration can noticeably slow your thought processes. You may fly for 30 minutes or you may fly for 10 hours but in many cases the most physically demanding stage of the flight is before takeoff.

It's hard to find shade at most gliding sites in Australia and most of the flying we do is in the heat of summer. Unless you take steps to carry water with you and deliberately drink while you pre-flight your glider and get it to the launch point, you may find that you are dehydrated by the time you strap in… exactly when you need to be mentally alert.

Unfortunately it is not easy to tell if you are dehydrated. If you take a sip of water, it can fool your body's thirst triggers for 15 minutes or more. You need to drink deliberately and often before and during your flight. It's easy enough to tell if you are dehydrated after the event… if your urine colour is any darker than a pale straw colour, then you are dehydrated.

Most of us who work in offices will take some time to get acclimatised to life in the sun compared with people who live and work in the open. Be prepared to take it easy for the first day or two of a gliding holiday and you will have a much better time of it.

It's also essential to carry lots of water with you when you fly. If you are planning to fly for longer than just 30 minutes, then you should carry much more water than a simple drink bottle. Nowadays it is easy to find rehydration systems at hiking, climbing and cycling shops which consist of a flexible bladder and drinking tube with a bite valve.

These systems can contain large amounts of water. Tough flexible bags containing 3, 4 and 6 litres with a tube and valve are available which can be stowed safely in almost all glider cockpits.

Remember that it is not the temperature of the water you drink which cools you. Drinking cool water is pleasant but your body is cooled hundreds of times more by the evaporation of water rather than just drinking it. If you keep your water container out of the sun, it should remain cool throughout the longest flight.

There's no doubt that plain water is the best thing to drink. There are sports drinks and other electrolyte preparations, but they're mostly designed for activities where lots of energy is used. In a sailplane, you don't use much energy but you do lose water through sweating and breathing. If sports drinks are used, they should be well diluted.

You also should be aware that plenty of fluids are unsuitable and can affect your hydration levels and general well being. You probably know the list already; alcohol, caffeine, soft drinks, fruit juice and fizzy drinks. A drink too many the night before or a cup of coffee too many before you fly can ruin your day.

Eating and energy

If you are in the air for long periods then you need to eat properly. If you let your blood sugar levels get too low you'll become sleepy and lethargic. Many of us find that when the going gets tough and we think we're going to be on the ground in ten minutes, a bite of some food can lift our spirits and get us going again.

It's important not to eat foods which are too high in sugar because the sudden increase in blood sugar levels when you eat can be followed by a sudden drop soon after making your mental state considerably worse. It's far better to eat food with a slow energy release.

To pee or not to pee

This is the title of an excellent article which was published a few years ago. Up until then, the subject of urination while flying was a well-kept secret. The fact is, since it is essential to drink while gliding, it is also essential to have some method of urinating in flight.

You may think "I'm only going up for an hour, I'll be able to land before I want to go", but this may not be possible. And the worst time to be cross-legged is while you are setting up a landing, so be prepared and have the equipment with you whenever you fly. Essentially there are two approaches… use a plastic bag possibly filled with absorbent material, or use what is coyly called a pilot relief system where a flexible tube is plumbed through the fuselage of the glider, exiting under the pilot or close to the undercarriage.

There's a wide range of choices and opinions on this and you'll probably have to find a method which suits you… and the method you use in a club glider may not be the same as you use in a privately owned glider. You can get a lot of information from talking to club members although some are unnecessarily shy about discussing this essential topic. Obviously, if you are a woman, talk to a female pilot! You won't find it difficult to get some other people's ideas.

Fortunately there's a also mass of information available on the web, much of it started by "To pee or not to pee". Search for this and "sailplane pilot relief systems" and you'll find reams of information. A good source of equipment and ideas can be got from looking at websites intended for wheelchair or bed-bound people and can easily be bought by mail-order.

Heat and the sun

Since the most common source of lift in Australia is thermic and the source of this is the sun, you need to be aware of the possible problems, risks and methods of avoiding prolonged exposure to heat and sun.

One thing to point out is that the biggest risk of getting too much sun is when you are outside the glider, before and after flight. Most sailplane canopies will filter out most of the UV, in some cases up to 99%. So it's when you're getting your glider ready and putting it away after flying that you have to be the most careful.

You need to wear good clothing and a wide-brimmed hat while on the airstrip. Wide brimmed hats are not good while flying because they affect your look-out so you also need a conventional gliding hat for inside the cockpit.

Many glider pilots wear a legionnaires type hat with a flap of fabric covering the ears and neck both on the ground or in flight. Many also wear long trousers and long sleeved shirts in flight. Unless it's a completely blue day, and unless you are for some reason staying low, it's mostly fairly cool when you are flying at cloud base so long sleeves and trousers are OK.

It's also quite common to see people wearing darker clothes and fabrics without patterns while gliding.

White and light coloured fabrics can be cooler to wear but light fabric and patterned hats cause reflections inside the canopy which can make lookout very difficult. In some clubs, white hats are banned in the front seats of two-seaters because the reflections make lookout difficult for the back seat pilot.

Many pilots wear gloves. These are either plain cotton gloves or lightweight gloves used for sailing, cycling, golf or driving.

Sunscreen

Obviously you should also apply good sunscreen every day before getting the gliders out. Be careful what type you use and where you put it and avoid getting it too close to your eyes. If you perspire and get sunscreen and sweat dripping down into your eyes it can sting like mad and make a proper lookout almost impossible for a time.

On a hot day, the hottest part of the day is when you close the canopy at the launch point. The temperature can rise rapidly and the last thing you want is for a trickle of sweat and sunscreen to get into your eyes just after the glider has left the ground. If you are lucky, the instructor will be there to take over. If there's no instructor, make sure there's no sunscreen near your eyes!

Comfort in the cockpit

Most glider cockpits are quite small and some single seater cockpits are tiny. It's important that you make sure you fit in the cockpit and also that you're comfortable well before towing the glider up to the launch point.

There are safety implications that need to be looked at first. You need to make sure that the rudder pedals can be adjusted to suit your legs. Next, you need to make sure that you can operate the other controls properly. In some gliders, you cannot use the airbrakes if you are wearing a wristwatch or have a wallet in your pocket. In others, you may find that you cannot retract the undercarriage.

While not being able to retract the undercarriage is a nuisance, not being able to use the airbrakes is dangerous so it's essential checking this before you fly the glider.

Getting the seat right is also important, especially if you want to fly longer flights. Some club two-seaters have a range of cushions which can be tried to get the right fit for you. If you are wearing a parachute, there are different styles of harness or different ways of packing parachutes which affect the way they fit in the seat pan.

In some gliders, the seat back can be moved fore and aft to suit smaller and larger pilots and may even be able to be removed altogether to fit the largest pilots.

If you find that you're getting aches and pains during longer flights, don't just put up with it, try and find alternatives to your seating arrangement so that you are comfortable and relaxed so you can fly at your best.

Have fun!

The point of gliding is to have fun. If you are not having fun, then ask yourself why. Many people enjoy a challenge but others don't. Breaking records is fine if that's what you want to do but if you don't want to raise your stress level and if you really enjoy boating around within gliding distance of the airstrip, then just do it! Don't feel that you have to fly comps and fly over the horizon if you don't enjoy it.

Set a goal

When gliding, goals are good. Every time you take off, you should have some sort of goal whether it's to try and stay airborne for 30 minutes, for five hours or to fly 1000 km. Not only should you set goals but you should try and achieve them.

There are a few reasons for doing this. For a start, having a goal, however easy, can help keep you focussed, alert and awake.

Secondly, having proper goals and trying to achieve them, will make you a better pilot.

Setting goals will keep you interested. Every time you leave the airstrip, you should be able to say to yourself, 'I did that better, flew further, faster or for longer than last time.' Even if all you can claim is one less bounce on landing, it's a step ahead.

If all you achieve is the same as you did last time, then sooner or later, you're going to forget the excitement of gliding and start to lose interest.

Airmanship

What is airmanship?

Let's assume that this term encompasses pilots of all genders… partly because the alternative terms are all pretty ugly.

Airmanship encompasses everything we do around gliders from before we open the hangar doors to closing them after a flight… and more. You can be a top competition pilot without being much of an airman in the same way that you can be a great racing skipper without being much chop as a seaman.

Airmanship is an attitude or state of mind combined with a heap of knowledge that covers not just flying skills but safety, maintenance, navigation, weather, engineering and so on. It may be the ability to calmly work out what that terrible banging noise is while spinning (it's the undercarriage doors) or knowing the best way to tie a glider down in the path of a thunderstorm.

In the case of the thunderstorm, luck may play a big part but this sort of good luck always seems to favour the people who are prepared for it. All air sports involve a degree of risk. Good airmanship involves understanding, managing and limiting many of the human, engineering and situational risks .

You

There's only one thing better than flying with friends and that's flying with old friends, people you've flown with over the years. We owe it to them and to ourselves to keep gliding as safe a sport as we can make it. It starts with you.

It's remarkable how many gliding accidents are caused by us, the pilots. While there are accidents caused by weather and aircraft, in most, the pilot plays the biggest rôle. You and me, we're the weak link in the chain.

Before you open the hangar doors or do a walk-around to inspect a glider, you should do the same thing to yourself. Aviation would be nowhere without acronyms and of course there's one for self-checking. And it's…

I'm SAFE.

- Illness.
- Medication.
- Stress.

It's remarkable how often some sort of illness, medication or personal stress is a feature in accident reports. Look at yourself carefully before you think about flying and if any one of these factors is significant, ground yourself. There will always be another day.

- Alcohol. World champion George Moffat said 'a gliding club with a good bar won't fail.' That may be so but there's absolutely no doubt at all that alcohol degrades every aspect of airmanship from coordination to judgement. Alcohol and flying do not go together. If you are hung over, tired, under the weather, don't fly.
- Fatigue. If you're tired before you get into the glider, from lack of sleep, heat exhaustion or too much activity, then don't fly. There are often times in a flight when you need 100% concentration and if you can't give this, don't fly.
- Familiarity. How long is it since you last flew? Are you familiar with the type of glider and have you read the flight manual? Are you sure the glider is safe to fly and has been rigged and DI'd correctly? Are you current with launching, stalls and spins? Are you familiar with the site and prevailing weather conditions? If you have any doubts about these factors, then read the manual or get a check flight.
- Eating. If you have not been eating properly both before a flight and on longer flights, eating and drinking enough water during the flight, you will not be able to perform at your best.

Lookout

Warning! Parts of this section may be depressing news! The fact is that humans, including you, are not born with a vision system which is intended for flight. Humans have evolved as hunters, not pilots and if we want to be good pilots, we have to accept the limitations of our eyes and brain, learn to look and see and make the best of what we have got.

While the skies in Australia can hardly be considered to be crowded, there are other aircraft out there and collision is a real risk when flying a glider.

Mid-air collisions occur in all phases of flight and at all altitudes. Nearly all mid-air collisions happen during daylight hours and in good visual meteorological conditions. Because of the concentration of aircraft near aerodromes, most collisions take place near aerodromes when one or both aircraft are descending or climbing but they also occur at higher altitudes and far way from aerodromes.

The cockpits of modern sailplanes are filled with all sorts of gear including GPS, colour moving map displays and Flarm anti-collision devices which sound an alarm if there's another glider in the area, so it can be a great temptation to keep your head inside the cockpit staring at your GPS or vario and relying on instruments like Flarm to keep you out of danger but this is the wrong thing to do. For a start, the aircraft may not be gliders and may not have Flarm fitted. There may also be so many gliders out there that the Flarm cannot give you enough information fast enough about possible threats.

The biggest aid to safety we all have is our eyes. It is not only essential to keep a good lookout, but we should also understand the limitations of human vision. Fighter pilots have extensive training in focus and scanning techniques to improve situational awareness and if we want to see better in the air, we have to learn how to look, so we can see as well as we are able.

This chapter aims to make you aware of some of the limitations of your vision and look at skills we need to learn to make our lookout more effective.

The practice of "See and Avoid" is the method that we use to minimise the risk of collision when flying. The effectiveness of See and Avoid can be greatly improved by learning skills to compensate for the limitations of our eyes and the development of scanning patterns that we use all the time and which form part of good airmanship.

All pilots are at risk of a mid-air collision. While a novice pilot has a lot to think about and may forget to maintain a proper lookout, even the experienced pilot who has flown many hours without seeing any hazards, can grow complacent and forget to scan. If you learn to use your eyes and your head it's not that hard to avoid mid-air collisions.

Causes of mid-air collisions

The reason most noted in accident reports 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 could have seen the other in time to avoid a collision… if that pilot had been watching properly. So it could be said that it is the human eye which is the leading contributor to mid-air collisions. Let's look at how its limitations affect your flight.

Limitations of the eye

The vast majority of our sensory input and therefore our situational awareness comes through our eyes. We depend on our eyes for the information necessary for flying the aircraft; attitude, speed, direction and proximity to other air traffic. As traffic density and closing speeds increase, the problem of mid-air collision increases considerably and so does the importance of effective lookout. A basic understanding of the eyes' limitations is the best insurance a pilot can have against collision.

Human eyes have primarily evolved to give us an edge when hunting and survival were probably a top instrument for that way of life. Our eyes are able to resolve quite small details and optimised to detect the moderately rapid movement of a running animal. This causes a few problems in a cockpit… the main one being that when an object is on a collision path with us, there is no relative movement.

If we are flying on a steady track, another aircraft on a collision course with us will appear as a stationary object in the distance. An image which is easily confused with a speck of dirt or scratch on the canopy. On the other hand, the aircraft we see moving in the distance is one we will not collide with unless one of us changes course.

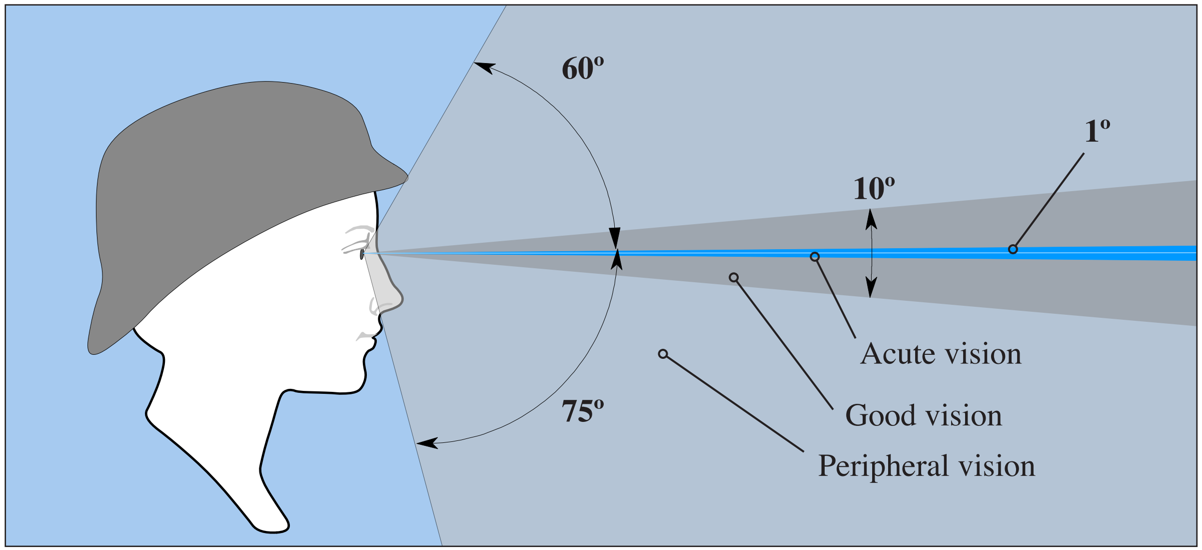
It takes time for your eyes to properly refocus between objects inside the cockpit back to the horizon, a drawback which gets worse with age. It may take as long as 10 seconds to properly refocus on a distant scene after looking at your instruments and people over 60 have very limited ability to change the focus of the lens in their eyes, if any at all.

Another focussing drawback is that the eye finds it difficult to focus unless there's something specific to focus on. In cloudy, hazy or dim conditions, you'll find it more difficult to pick anything than in bright, contrasty conditions. This is actually made worse by binocular vision. If you only see something through one eye, your mind may not process this as being a threat worth concentrating on. If your eyes don't find anything worth focussing on, after 30 seconds or so, they'll shift focus back to about 10 metres… no more than a wingtip away.

Humans have a relatively narrow field of sharp vision. Our peripheral vision covers about 160° horizontally and 135° vertically but this is only good for detecting moving objects and forming a picture of the position of things like the horizon. Our field of sharp vision is much smaller than that.

Within a 10° cone, our eyes work well. Outside this cone, visual acuity drops by 90%. However our highest acuity vision is limited to a cone of about 1°… that's about the size of a ten cent piece, one metre away.

The further a hazard is outside this 1° cone, the more difficult it is going to be to see. In the sharpest 1° cone, you might recognise another aircraft 10 kilometres away but outside the 10° cone, you would not see it until it was 1 kilometre away.



Next time you are at the launch point, find a glider circling some distance away. Look closely at the glider to fix its position and then look away about 15°. The chances are that without refocusing back at the glider, you can no longer see it, even though you know where it is. That's because the glider is now outside your sharp 1° cone. This makes a scanning pattern essential and looking at distant objects to make sure our eyes don't close-focus.

Your vision can be made worse by many things including stress, smoking, sickness, sunscreen in your eyes, dust, age, tiredness and hangover. That's just the beginning. Your vision is also made worse by haze, glare, canopy distortion and cleanliness, temperature, lack of oxygen, G forces…

Rather than continue with this list, lets get to the point. Even though we may have excellent eyes, our vision is limited in many ways and we have to learn to make the most of what vision we have.

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.

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-front of the canopy); 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, if it is necessary to look at the instrument panel, do a quick scan of that and then repeat the external scan.

Learn how to scan properly by knowing where and how to concentrate your search. You cannot look everywhere at once so concentrate on the most critical areas at any given 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. Scan at least 10 degrees above and below your flight path. Your focus point should be shifted at regular intervals.

Scan in a series of short, regularly spaced eye movements that bring successive areas of the sky into your field of sharp vision. Each movement should not exceed 10 degrees and each area should be observed for at least one second to enable detection.

Although horizontal scans seem preferred by most pilots, you should develop a scanning pattern you find comfortable and make it a habit. Remember that aircraft which appear to be stationary in relationship to your aircraft are actually the biggest threat.

Lookout scanning

Below are lists of scan types and when to use each scan type. Each scan type uses a different scanning focus based on where you need to look for other aircraft. The frequency of each scan type within each activity should be based on the need for appropriate situational awareness.

Scan Type	**Method**
Cruise Scan	The main collision zone 60º left & right, up & down.
Full Scan	Complete visible sky scan. Left & right, up & down as far as you can go for situation awareness.
Targeted Scan	Concentrate on the part of the sky where the hazard is expected as a response to events such as a FLARM warning or incoming radio alert.

Activity	**Scan Type**
Cruising	Cruise & Full Scans.
Flight mode change*	Cruise, Full & Targeted Scan as appropriate to the mode change.
Manoeuvre	Cruise, Full & Targeted Scan as appropriate to the manoeuvre.

At each stage in flight we need to be alert to traffic, generally in the airspace around us but also consciously focussed in areas more likely to have traffic. We should be aware that traffic can be present even from unlikely directions. Each flight mode has it's own specific scanning requirements.

Flight Mode Change	Scan Type
Post launch	Full Scan.
Pre-Landing	Full Scan for other traffic in the circuit area with appropriate radio calls when inbound on final glide or joining circuit.
In-circuit changes	Targeted Scan watching for other traffic joining circuit, turning base and final and gliders making modified circuits. Appropriate radio calls.
FLARM or Radio Alert	Full Scan and Targeted Scan directed towards the alerted location without getting fixated.
Start Point	Full Scan for other gliders starting a comp.
Turn Point	Full scan for gliders entering and leaving from other directions and at other heights.

At high airspeeds, scanning should be concentrated on a narrower cone… straight ahead and 60º either side with regular but less frequent full scan lookouts. Around airstrips, scanning should be rigorous and accurate. High speed pull-up manoeuvres are dangerous because of blind spots and should be done with great caution.

Manoeuvre	Action
Change of course	Targeted scan towards and prior to the course change.
Turn	Before and during the turn, scan in the direction of the turn and look for gliders behind.
Pull-up	Full Scan prior to the pull-up and a Targeted Scan watching for traffic above.
Thermal approach	Full Scan and Targeted Scan directed towards other gliders already in the thermal, other gliders entering from different directions and different heights, gliders entering doing pull-ups and gliders leaving.
In thermals	Full Scan and Targeted Scan for gliders circling, joining and leaving as well as gliders climbing through a gaggle or circling wider or tighter.
Thermal leaving	Full scan for gliders entering and leaving from other directions at other heights. Change to Full Scan and Cruise Scan.

Time-sharing

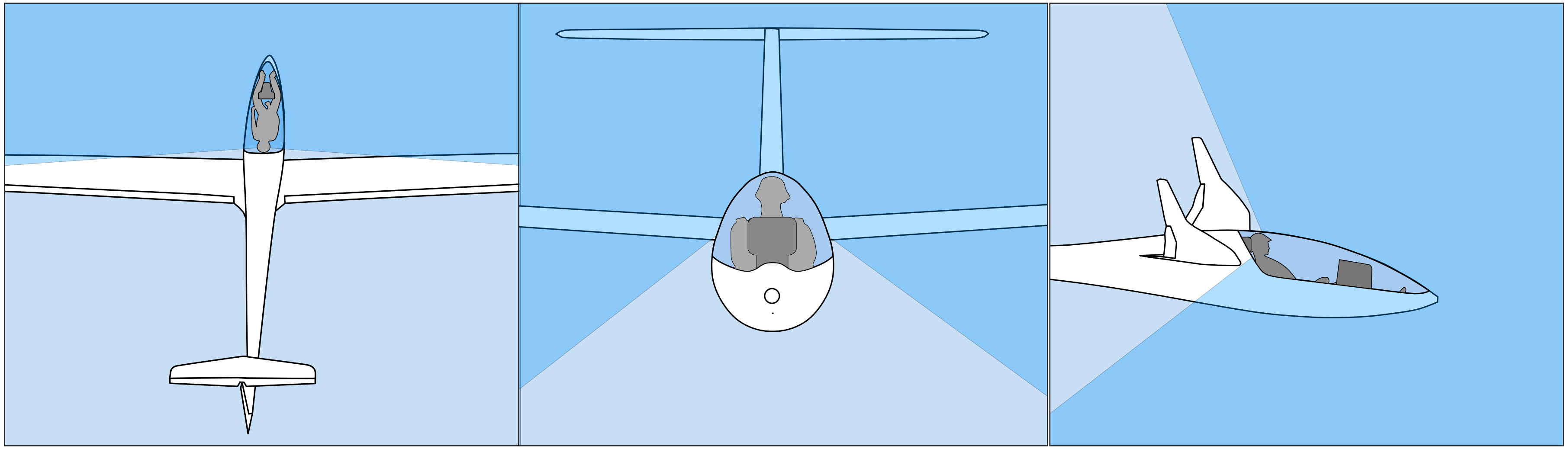
You should not spend too much time looking inside the cockpit. You should only spend 2-3 seconds of every 30 seconds looking at your instruments. The increase in cockpit gear like GPS devices with moving map displays can be a mixed blessing.

They may reduce the time spent map reading, but tasks like entering or changing waypoints can be time consuming. Break up these tasks with frequent scans outside the aircraft.

Blind Spots

All aircraft have blind spots, and if the pilot is not keeping an active lookout, the blind spots may be 100%! While gliders have large canopies and theoretically offer an excellent field of view to the pilot, there are still huge blind spots especially if you don't move your head enough.

You should be aware of your aircraft's blind spots and bear in mind where other aircraft may be whenever you manoeuvre, especially when turning, on finals and entering thermals.



When entering thermals, where there are already gliders circling, be very aware that a circling glider acts like a magnet to any other sailplanes in the area and it may not be just you who is heading towards the thermal. Make sure that you don't do a rapid pull-up to slow down as you enter the thermal… there may be someone above and behind who you cannot see.

As you enter, scan left and right to look for gliders coming in from other directions. Make a shallow banked S turn as you approach… a banked glider is easier to see than one with wings level.

Try to enter the thermal on the opposite side of the thermal to any other glider which is close to your altitude and always turn in the direction set by the first glider in the thermal.

Sooner or later, you may be sharing the thermals with other gliders such as hang gliders and paragliders. These pilots of these aircraft have a very different set of blind spots. Both can see best forwards and downwards but have large blind spot areas above and behind. You should bear that in mind and make sure that you can both see each other.

There have been occasions where two gliders on finals have collided. You will not see a glider directly below you and the lower pilot is likely to be concentrating on the view directly in front instead of what is above.

The best time to scan for other gliders in the landing pattern is when you turn onto the base leg, before you turn onto finals. With the glider's speed stabilised, it's a good opportunity to look for aircraft ahead about to turn on to finals and any who might be on long finals.

It's a good idea to make any radio calls just before you make turns… "Alpha Bravo turning base." will alert others in the pattern in a way that should tell them where to look for you.

Avoiding Collisions

As a pilot, you are responsible to make sure your vision is equal to the task of flying. Vision is a pilot's most important sense and we need to learn how to use it. There are plenty of things you can do which minimise the risks of collisions when flying:

- Develop an active scanning technique.
- Don't spend more than 3 seconds every 30 seconds looking at instruments.
- Scan the entire horizon, not just the sky in front of your aircraft.
- You are 5 times more likely to have a midair collision with an aircraft flying in the same direction than with one flying towards you.
- In many collisions, at least one of the pilots involved was not where they were supposed to be.
- Keep clear of clouds, fly a proper circuit and if you are going to do anything unusual, try to make a radio call.
- Avoid self-imposed stresses such as self-medication, alcohol, smoking, hypoglycaemia, sleep deprivation, and fatigue.
- Use oxygen above 10,000'. It's mandatory.
- The sharpest distant focus is only within a one-degree cone.
- Outside of a 10° cone, visual acuity drops 90%.
- Always look out before you turn and make sure your path is clear and then keep an active lookout in the direction of turn.
- When you are close to an airstrip be especially aware of other aircraft in the circuit.
- Whenever you join downwind, turn onto base or final, scan the area ahead of you on both sides to check for other aircraft coming from unusual angles, on modified circuits or straight ahead approaches.
- On finals, it's easy to get fixated on your aiming point or at a larger aerodrome, the 'piano keys'. You may never arrive at the runway if another pilot is also aiming for the same place at the same time, so keep a good lookout either side when on finals.
- During aerotow descent and climb-out, tug pilots must make gentle clearing turns to see if anyone is in the way. The visibility from a tug is not as good as from a glider so if you the glider pilot see a potential threat, you should always alert the tug pilot and request a

deviation if necessary.

- Before takeoff, scan the airspace and the runway to make sure that there are no aircraft or other objects in the takeoff area.
- After takeoff, scan to ensure that no aerodrome traffic will be an obstacle to your safe departure.
- Remain constantly alert to the possibility of any traffic within your normal field of vision, as well as periodically scanning the entire view outside the aircraft to ensure detection of conflicting traffic.
- In the event of a near collision, be careful of making a steep turn. A banked glider takes up more airspace than one flying level. It's better to climb or dive to miss an aircraft which is close to you.
- Remember that high performance aircraft will have high closure rates reducing the time for detection, decision, and evasive action.
- If you are using a GPS, make sure that all the required waypoints are in your GPS before takeoff.
- Make sure that you have maps to cover the area you are flying in and that restricted airspace, tasks and courses are marked on your map. Fold maps so you can see the important sections and put them somewhere accessible before you take off.
- Make sure that your canopy is clean before you take off. It's easy to confuse a scratch or mark on the canopy with a collision threat.
- If you cannot avoid aerodromes en route, fly over them well above circuit height and monitor the local frequencies. Be aware that GA aircraft frequently travel in straight lines between major centres. Flying off to the side of these routes is a good idea.
- Use all available eyes. One of the great advantages of two seaters when flying, especially when flying cross-country or in crowded airspace is that there are two pairs of eyes. While one pilot is concentrating on flying, the other can be navigating, making radio calls and adding to the overall lookout.
- Keep Scanning! The most important thing to avoid collisions is to keep a good lookout. Make use of your scan constantly.

Gliding Safety

Few activities can claim to be completely safe and most sports involve some degree of risk. In fact the most dangerous sport in Australia is supposedly rock fishing. Sports such as football, motorcycle racing and horse riding are several orders of magnitude less safe than sailplanes.

Gliding is an adventure sport, but it is not really an extreme sport. Gliding is as safe or safer than general aviation, and ranks with a big group of sports not generally considered unsafe such as tennis, swimming, scuba diving, mountain climbing and so on, but because of the relatively few participants in many niche sports like gliding, it's difficult to get statistically relevant information.

When you are thinking about your own personal safety in sport, it might be useful to look at the injuries and fatalities as separate groups. Compared with other gliding activities such as hang gliding and paragliding, the incidence of injuries, especially long term injuries in sailplanes is very low, even though the fatality rates are similar.

Risk management

You can mange the risks associated with gliding. It can be a personal choice to avoid activities which you perceive to be less safe than others. Ridge soaring and mountain flying are more dangerous than thermal flying, and circling in gaggles with other gliders, more likely in competitions, is more dangerous than flying alone. Winch launching is more risky than aerotowing and self launching gliders have their own set of risks. Bear in mind that many recreational activities like gliding are dangerous, but the personal challenge of managing the risks is extremely rewarding.

Causes of accidents

Most accidents in aviation are due to pilot error. Very few indeed are due to structural or maintenance problems with gliders. It's difficult to break down the small number of accidents in sailplanes into categories which give a meaningful result.

There was a time when mid-air collisions in competitions were significant but for various reasons, including a change in the way that many competitions are run and the almost universal adoption of anti-collision technologies such as FLARM, mid-air collisions are now rare.

Minimising risks is best approached by a safety management system which involves everyone. It's a state of mind which begins when you enter a sport and involves every part of the activity from maintenance through to after-gliding activities. With a complex activity like gliding, where each of us depends on many others, it's essential that everyone has a mindset to maximise safety, all of the time.

Parachutes

Wearing parachutes in gliders is not mandatory in Australia but most solo pilots and all competition pilots wear them.. That's a good start but you also need to know how to operate this parachute!

A well known gliding coach (who has bailed out of a glider) says that we should consider the possibility of a bail-out as part of gliding, think about it more and rehearse an "exit check" in the same way as we routinely do pre-takeoff and landing checks.

Rehearsing a bail-out

The sequence with a bail-out is Canopy, Belt, Bum, Cord. It is essential to practice this as a sequence in every type of aircraft that you fly so you don't waste valuable time.

As they say, subtly, every aeroplane is different. Almost every type of sailplane has a different method of releasing the canopy, Many have different seat belt harness releases and the rip cord handles on parachutes can be in different places.

Before flying any new type of glider you should take some time to familiarise yourself with the controls, their position and in the case of undercarriage controls, the sense of operation.

Locate and identify the canopy release, reach out and touch it. Many canopy jettison handles are shape coded so they have a unique feel compared with the canopy latch. Identify the seat belt harness release, reach out and touch it. Look at the ripcord handle. Move your hand to the ripcord handle.

Get into a habit of visualising bailing out and hopefully you will never need to. When you are stabilised after take-off and have time to spare, practice a deployment sequence. Remember that in many cases you may be spinning or tumbling and it will be difficult to move your hands towards the ripcord handle without considerable effort.

When skydiving, you may be told to get stabilised before pulling the ripcord but when bailing out of a glider, it's recommended that you pull the cord immediately, before any tumbling makes this difficult or impossible.

It is essential to look and touch! A hang glider deployment will serve as an example. The celebrated Robbie Whittal deployment goes like this. Robbie was in an aerobatic championship above Monaco when he did a bad loop and had to throw his parachute. He grabbed at the deployment handle and tugged like mad… again and again. Some time later, puzzled by the non-appearance of a parachute, he looked down and saw he was tugging at his camera strap.

- The most important thing about parachutes is to have one when you need it. Most training is done without a parachute. In competitions, where the risk is higher, all pilots wear parachutes.
- The second most important thing, is that your parachute must work when you need it. Make sure your parachute is repacked and current.
- And the third most important thing is that it must not deploy when you don't need it. This last point is not normally an issue except where static line or ballistic parachutes are used.

A parachute is designed to reduce the level of poo you are in from above your head, to just below your nose. But if the chute opens when you don't need it, then the level goes from zero to above your head in an instant.

Most emergency parachutes will open. The failure rate of a skydiver's main chute is relatively high because of its design and the way it is packed and repacked. However the failure rate of backup parachutes is very low even if they are not current. So wearing a parachute is better than not wearing one.

Parachute repacking

A parachute which has not been recently repacked will most likely open OK, but it may take longer than a recently repacked canopy. The recommended repack time of emergency parachutes is 6 months. However the 6 month repack cycle of a sailplane parachute should be taken as the maximum if you get more than usually hot and sweaty in the cockpit or if a parachute gets wet through a spilt water bottle.

Wearing a parachute

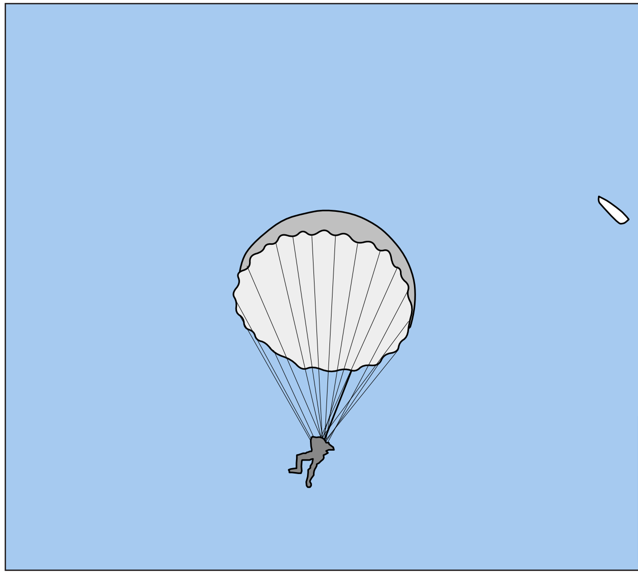
There is a right way to put on a parachute. Unless the manufacturer says otherwise, the chest strap should be secured before the leg straps are done up. This should be done as a routine so the chest strap is always done up first and not forgotten.

Before putting on your parachute, open the back flap a little to expose the rip cord cables. The cable ends should extend well through the grommet openings and be safetied. Check the rip cord handle. It should be securely fitted all the way into its pocket or elastic loop. Some pilots put a piece of coloured tape on the handle for rapid visual identification.

Check for the general integrity of the container. The canopy should not be visible. If a round external spring loaded pilot chute is installed, make sure it is secure around its circumference.

Parachutes should never be left in a cockpit. They should be stored in a cool dry place. Nylon is degraded rapidly by UV light and although most sailplane parachute harnesses are made of reasonably thick material, why take the risk by leaving a parachute unnecessarily exposed to sunlight?

Don't get parachutes wet. Nylon also absorbs water and loses strength when wet. In yachting, many spinnakers fail when they first come out of the bag because they are wet. Once the spinnaker dries out, it increases in strength by as much as 10%.



If you bail out at altitude, be aware that the glider may spin like a sycamore seed and its descent rate may be close to yours.

When to bail out

If the sailplane is obviously in an unflyable condition an immediate and rapid bail-out is the only option. When a glider is damaged this badly, the chances are that not only is this decision unnecessary, but the immediate problem is how to get out of the glider.

If there is the slightest hint that the glider is unflyable, then immediate and rapid exit is the only option… and this should be planned for and rehearsed as far as possible!

There are several main reasons why we might want to bail out.

- After a mid air collision with an aircraft or large bird. Probably the most likely event.
- Failure of an essential control system of the sailplane.
- Failure of the aircraft structure which renders it unsafe.
- Smoke or fire. More likely in self launching gliders.

If one of these events occurs, there are many possible outcomes.

At one end of the spectrum, the glider is obviously unflyable and at the other end, the glider is still flying and controllable but there is a significant doubt. An example of this is where a pilot had a mid-air collision but decided there was no damage. He landed and found that one side of his horizontal stabiliser had broken off.

At the other end of the spectrum, the glider is controllable but it feels as if something is seriously wrong… for example an aileron linkage has parted in flight or that the glider has been incorrectly rigged.

In one instance of aileron disconnection, the pilot never noticed until the aircraft had landed. In another, the pilot called for help. Another pilot flew over and saw the aileron flapping. In this case the pilot elected to bail out rather than risk landing with only partial control.

In a “flyable” but doubtful condition, the pilot should spend a moment considering the options.

• Is the glider really damaged? If a collision impact is not visible from the cockpit, it’s safer to bail out than run the risk of staying in the glider. If the impact area is visible, for example on a wing, then it might be possible to remain with the glider.

• Is the damage significant? A bird strike may cause damage but probably not of the same magnitude as a collision with another aircraft.

• Is the terrain over which the aircraft is flying suitable for landing in a parachute? Will this condition change?

• Is there enough altitude for a successful parachute deployment?

• In the case of a fire in an SLG, most engine compartments have a fire rating of perhaps 5 minutes before the fire will spread and perhaps damage control linkages. In this case, is the glider low enough to land safely or high enough to allow for a successful bail-out?

The bailout sequence

The sequence is Controls, Canopy, Belt, Bum, Cord.

Controls. The first thing to do is to stabilise the glider if possible and open the airbrakes to slow it down. A Piggot hook is useful here because it allows the airbrakes to be locked open as well as preventing them opening when not required.

Gliders are slippery by design and will accelerate rapidly into a spin, spiral dive or some uncontrolled manoeuvre. Opening the airbrakes will slow the glider down and give you a little longer to get out.

If significant parts of the wing are lost in a collision, the resulting motion may be chaotic. G forces may build very rapidly so that a pilot does not have the physical strength to push out of the cockpit or is in danger of blacking out so it is essential to act fast.

If the controls are working well enough to stabilise the glider, do this now. It will make getting out a lot easier. Once the canopy is released, you can then push the stick forwards and try to outside loop or bunt the glider. If the elevator or tail boom is broken, the glider will probably nose over into an outside loop by itself, however this is good for a fast exit.

Canopy. Glider canopies are fastened and jettisoned in many ways depending on whether they are front, rear or side hinging. The canopy jettison lever is coloured red, but almost every glider manufacturer has a different idea about the shape, size and position of these levers.

Jettisoning the canopy may not be straightforward. You may have to pull levers using enough force to break safety wire connections.

Having released the canopy, it may fly back in the slipstream and bean you. This happens enough times that Prof. Roeger of the Aachen University in Germany invented a simple hook-shaped pin located at the back edge of the canopy which solves this problem.

If you have a Roeger hook fitted, the front of the canopy should lift and then pivot around the pin before flying off. Most new gliders have a Roeger hook fitted, and most older gliders can have them retrofitted.

If your glider has a single canopy jettison handle, locate and hold the lever, lean forwards as much as possible and shield your face with one arm as you pull the lever with your other arm. Many gliders have a headrest attached to the canopy. Leaning forwards will minimise the risk of being hit by the headrest as the canopy flips up. If you need to pull two levers, just lower your head as much as possible when jettisoning the canopy.

Use this head-down time to locate the seat belt harness release.

There's no guarantee that the canopy will fly off by itself. The pilot should be prepared to push hard upwards against the acrylic to force the canopy off the cockpit.

Once the canopy has been released, things inside the cockpit may get fairly chaotic because of the force of the slipstream.

If it's at all possible, push forwards on the stick and pitch or roll the glider inverted.

Release the seat belt harness. Don't just feel for the harness release, look at it before operating!

If you are lucky, the harness releases easily and you will be thrown out of the glider. Most likely you will release the harness and find it difficult to lever yourself up and out of the cockpit. If the glider has entered a spiral dive, the G force may quickly and easily exceed 2 G. That's going to double your body weight.

Why not lie down on your back and get a friend of similar size to lie down on top of you. (Let people know what you are doing first!) Now, put your hands down on the ground and try and push the two of you up far enough to clear a notional cockpit side.

Many pilots who have had to exit a glider this way have found it very hard and it may take several attempts and require almost superhuman strength. Don't give up! The chaotic motion of the sailplane may mean that the next time you try, you will succeed.

The late pilot and writer Jochen Ewald frequently commented on the need for small bumps or hollow purchases to be put in a cockpit floor to allow a pilot to dig their heels in and lever themselves out.

If all else fails, lean forwards and pull the ripcord now. The pilot chute may be dragged into the slipstream and inflate the chute, pulling you out of the glider.

If the sailplane is an SLG and the engine is extended or running, this whole procedure may have to be modified because the engine should be stopped and retracted before bailing out. Use the emergency or manual override to retract the engine. If the propellor is still turning, don't worry, it will stop when it hits the engine bay doors. Hopefully the manual retract switch is latching, so as soon as you have started the retraction process, you can get on with the rest of the bail-out process.

As soon as you have got clear of the cockpit, you can pull the rip cord and you have survived! Of course, it is not so easy and you are by no means safe yet.

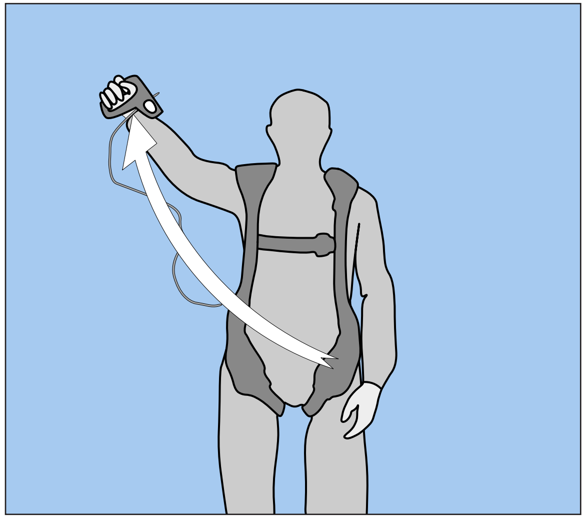
The ripcord

Now pull your parachute rip cord. Look at the rip cord handle, reach out quickly with both hands if possible. If you can only get one hand on the rip cord handle, your other hand can be used to stabilise the hand on the rip cord. The rip cord should then be firmly pulled all the way out with a circular motion across the body.

Possibly the biggest impediment to pulling the rip cord is going to be tumbling and the second, the violence of the airflow. If you start to tumble, G forces may build up so fast that you are unable to bring your arms back in towards your body to pull the rip cord so pull the cord as soon as you can after exiting the glider.

If you are tumbling, then probably getting into a face forward, spread-eagle position like a sky-diver will stabilise the tumbling and allow you to reach the rip cord.

Once the ripcord is pulled, the chances of your canopy not opening are small. If the parachute doesn't open cleanly, then fight it! There are some "interesting" videos on the internet taken by sky divers who have had a partial opening failure of their parachutes heaving on the bridle and lines to get their canopy to inflate.



Suspended in your parachute, and quietly descending, you're probably elated that you have survived but take a moment to consider your next options. Where are you going to land? It is well worth avoiding power lines, roads, trees, buildings, water and downwind landings.

Steering a parachute

Most emergency parachutes can be steered. The parachute's instruction manual should have details on this.

Typically, the parachute will have vents towards the rear of the parachute and can be steered by pulling on the two webbing handles attached to the risers, or pulling on the rear risers themselves. The handles have to be pulled firmly down to chest level. The parachute will continue to turn until the steering line is released and will take about 3 seconds to stabilise.

Remember, when the parachute is being steered or turning, the descent and forward speed both increase, so get your steering done early.

Look down to see if you are drifting forward or backward. If you have the chance look for a landing spot, look for it downwind and turn back into the wind for your final approach.

Your landing spot will be somewhere between a 45º to 60º angle as you look forward and down. The landing spot should appear to remain stationary as you descend. Do this early to avoid steering turns at a low altitude.

Landing in a parachute

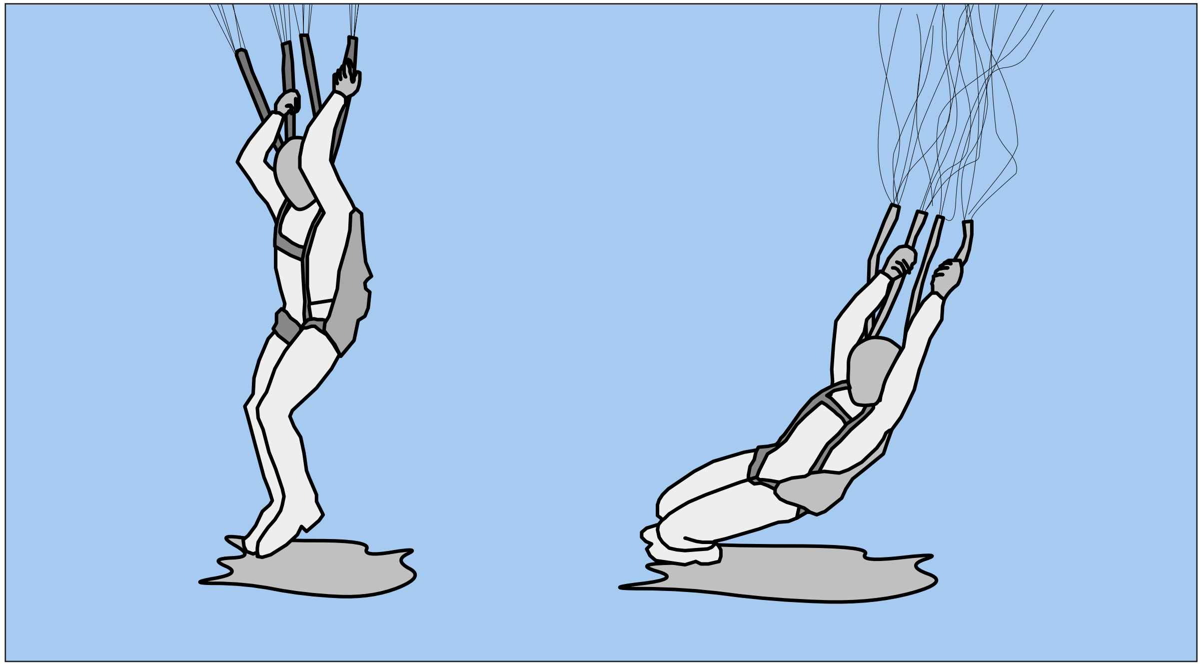
Before landing, lock your legs together from thighs to ankles. Bend your knees slightly forward and…

Brace yourself as if you were to jump off a 2 metre high platform. As you hit the ground, turn your body slightly sideways and roll along your side to absorb the landing shock.

The parachute may remain inflated after landing, if winds are greater than 10 kt. If you are being dragged across the ground by high winds, roll onto your back. The parachute container will provide some protection from abrasion. Reach up and grab one of the lower rigging lines of the parachute and pull down hand over hand until the canopy is distorted enough to collapse.

If you are going to land in water, release the chest strap as you descend under the parachute. This will save time in the water. Turn the parachute to face 'into wind' to land as you would for a normal landing. Facing into wind is absolutely necessary for all water landings.

Be aware that if you land in water facing into wind, you may be towed across the water on your back (face up) if the wind strength is high.



If you land facing down wind, you will enter the water face down and may be dragged under.

After landing in the water, release both leg strap snaps. Discard the parachute and swim away. Always head up wind and up current away from the parachute to avoid entanglement. Once it's water logged, the parachute will sink.

If there are any power lines in the vicinity, steer away from them downwind. If you are unable to avoid power lines, push your feet firmly together, turn your head to the side and try not to touch more than one line.

If you connect with live cables and find yourself suspended above the ground, make sure power has been disconnected before a rescue attempt is made. This may take hours.

There are several instances of rescuers being electrocuted trying to save someone from power lines while the person hanging from the power lines survives.

Unless you are sure that the power has been disconnected, don't let anyone on the ground come near you. Remember that most high voltage lines will have a circuit breaker that will automatically attempt to reconnect the power a number of times.

Always steer the parachute to avoid trees. If a tree landing is unavoidable, place your feet and knees firmly together, tuck your elbows into your stomach, protect your face with your hands. Place your chin on your chest and hold on. Once you are in the trees, you can either use your parachute lines to lower yourself to the ground, or better, to tie yourself to the tree until help arrives.

Many hang glider and paraglider pilots carry a roll of dental floss in their harnesses which is strong enough to be used to raise a rope from the ground.

Static line parachutes

For most people, the options to improve your chances of a successful bailout are limited to rehearsals, but here are some other things to consider.

A static line parachute can be opened in two ways. One is using the rip cord as normal. The other way is to attach the static line on the parachute to a strong point on the glider.

Most gliders have a strong point fitted, but it's fairly easy to install one or to connect to an existing structure. If the glider needs any modification, talk to your Regional Technical Officer - Airworthiness (RTOA).

Using a static line parachute should completely eliminate one part of the deployment procedure, and it should work even if you cannot get a hand on the rip cord. If the static line system fails for some reason, you will know pretty soon and can fall back on pulling the rip cord.

There are a few possible disadvantages. One is that the static line gets tangled around your arm or neck as you leave the glider. Another is that the deployment sequence will start as soon as the end of the static line is reached.

If you have a static line, more thought is required when getting out of a glider after a normal landing to avoid extending the static line but it's about six metres long and the Velcro enclosure makes a noise when the line is pulled out making this only an inconvenience.

NOAH

DG sailplanes invented the NOAH system and have made it available to other manufacturers. It can be fitted to any new sailplane and retrofitted to many existing ones. Essentially, NOAH is an air-bag system which rapidly inflates, raising the pilot to the level of the cockpit side in about a second and allowing the pilot to just roll out instead of climb out.

On a glider fitted with a NOAH system, the pilot jettisons the canopy as normal, and then pulls on a toggle to activate the NOAH system. This not only inflates the bag but also releases the seat belt automatically. It is impossible to deploy the NOAH system until the canopy has been jettisoned.

Even though the NOAH system has interlocks to prevent the inadvertent deployment of the air-bag, tests have shown that even if the air-bag does inflate when the seat belt is still done up, all the pilot gets is a good squeeze for 2 seconds or so until the porosity of the air-bag lets the air escape and reduces the pressure.

In a glider fitted with NOAH and a static line parachute, the exit sequence is hopefully reduced to two actions. Jettison the canopy and pull on the NOAH operating toggle.

Ballistic Parachutes

A ballistic parachute system is normally used to parachute down an entire aircraft and pilot. The attraction is obvious. One pull on the actuating lever and a rocket or spring fires a line out of the aircraft which deploys a drogue chute which pulls out a full size parachute. The pilot has the protection of the cockpit, perhaps a modern reinforced safety cockpit, to absorb the landing impact and hopefully both aircraft and pilot are saved.

The arguments against ballistic parachute systems are however considerable. Expense, size and weight and unwanted deployments and uncontrolled descents being the main ones.

- A ballistic system, because it supports the entire glider and pilot, must withstand a much greater opening shock and be able to support at least four times the weight of a conventional personal parachute. This means that ballistic systems are large, heavy.
- In fact, where they can be fitted to sailplanes, they normally fit into the space where a self launching or sustainer motor might be fitted, so you cannot fit a motor and a ballistic parachute.
- Ballistic parachutes are much more expensive than a NOAH system.
- The incidences of unwanted deployment are low. BRS have installed over 30,000 systems in sport and defence applications which must be some testimony.
- Once a ballistic parachute system has been deployed, the pilot becomes a passenger and lands where luck and the weather take them. This is not an ideal situation by any means.

In Germany and possibly other EU countries, it is mandatory for aircraft such as ultralights to be fitted with a complete aircraft rescue system. The German regulations for maximum opening time at a specific speed and weight are such that the aircraft mass and structural complexity is significantly increased.

Because the size, weight, operating speed and opening shock and opening time constraints are in opposition, it is virtually impossible to have a short opening distance and a low opening shock. In practice, the opening distance appears to be shifted upwards by 80-120 metres compared with a conventional human-operated parachute.

That is, a ballistic parachute takes longer to open, and therefore the minimum deployment height is higher.

You and your parachute

We are actually not so interested in the opening time of a parachute. We are interested in the opening distance.

If you are 50 metres above the ground, you don't care if your parachute opens in one or two or three seconds, you care that it opens in 45 metres or 55 metres. The opening distance, all things being equal, is a function of the size of the parachute. A small parachute will open in a shorter distance than a large one.

The opening distance is almost precisely a function of the opening time squared, i.e. doubling the opening time requires basically 4 times the opening distance. A human operated parachute may open in 2.5 - 3 seconds. In Germany, a ballistic parachute is required to operate in 4.5 seconds.

The size of parachute you carry really should be a function of your age. How fast do you want to fall, and how quickly do you want the chute to open? We all want the fastest opening times possible, but fast opening means a small area chute and that means a faster descent rate.

While a 20 year old may be able to jump down from a 3-4 metre high wall without injury, a 50 year old cannot expect to do this without being

hurt so the older you are, the larger your chute has to be.

On the face of it, there might seem benefits in glider pilots doing practice jumps in parachutes. Unfortunately, for older pilots, the risk of being injured in any jump is high so there may be no real benefit.

Statistically speaking, the chances of having to bail out of a glider are very, very small, but bailouts do happen. For that reason, you should make sure that you and your equipment are ready for this small possibility.

Always put your parachute on and remove it when you're outside the glider. Fit the chest strap first, then the leg straps. It the parachute has a static line, make sure it's ready to attach to the glider. Check the rip cord to make sure it's in place and not dangling loose.

Onwards and Upwards

Onwards and Upwards

Most of us at some stage, want to get out of training gliders into a higher performance glider. This often happens as soon as a single seater appears on the strip beside our training two seater.

Some achieve the move to higher performance gliders fairly soon while others of us seem to spend a hundred hours or more in training gliders, either because we're happy flying like that or because the authorities haven't offered us a ride in anything else.

In some gliding sports such as hang gliding or paragliders, high performance wings can be a little too exciting for a low hours pilot, not only to fly but to launch and land.

Fortunately, most high performance glider types are not that much different to flying a low performance or a training glider. High performance gliders are not particularly twitchy to fly because the design standards are the same as all modern gliders, at least as far as handling and safety is concerned.

There are gliders where a club's handing notes says it 'spins easily and fast,' but even those are not so different that anyone with a degree of skill and caution cannot get in one and fly it safely.

There are differences between high performance gliders and low performance ones of course and these are mainly:

- Drag
- Weight
- Size
- Strength

Drag. The biggest single difference between a heavy training glider and a high performance glider of similar weight is drag. Everything from the frontal area to the wing section of the high performance glider is designed to reduce drag. Obviously for similarly heavy gliders, the total lift must be more or less the same, so the increase in performance is gained from the fact that there's less slowing the glider down.

In practice, this means quite a lot. The glider is a lot more slippery and it will gain speed much faster if you don't pay attention. When aerotowing, it's easier to get some slack in the rope and when landing, you have to pay closer attention to your airspeed through the whole circuit.

A lack of attention in some phases of flight can lead to over speeding which needs to be very carefully watched. Make sure you read and understand the performance envelope and placarded limits in the glider's flight manual.

While high performance gliders have to handle much the same in a spin as a training glider, their low drag will mean that spins can result in higher speeds and a greater height loss before recovery. This means you must be especially careful to maintain a safe speed near the ground in the circuit in a high performance glider.

Weight. High performance gliders are often fairly heavy, especially self launchers and gliders fitted with a sustainer. They often have the capacity to carry around half their weight and more in water ballast.

This extra weight affects the glider's dynamics. You can't expect a heavy glider to pop out of a sideslip or a spin like a training glider. In a fully developed spin, a heavy glider, especially one with a big wingspan, will wind up more than a light glider and take longer to pull out. Some very big wingspan gliders are not permitted to spin at all.

Heavy gliders take longer to stop after landing. Most modern gliders have stall speeds 20-30%

faster than the last generation of wood gliders and land faster and take longer to stop, even with good brakes.

Size. Most modern high performance gliders are being made in 18 and 21 metre wingspans and there are a few open class gliders with wingspans up to 29 metres. An 18 metre glider doesn't feel much different to a 15 metre glider in terms of control response when airborne but by the time you get up to 25 metres, the handling is quite different.

Big wingspan gliders cannot bank and turn as quickly and as tightly as smaller gliders and the diameter of their circles when thermalling is larger. Big wingspan gliders normally have a lower Vne but an eye watering glide ratio.

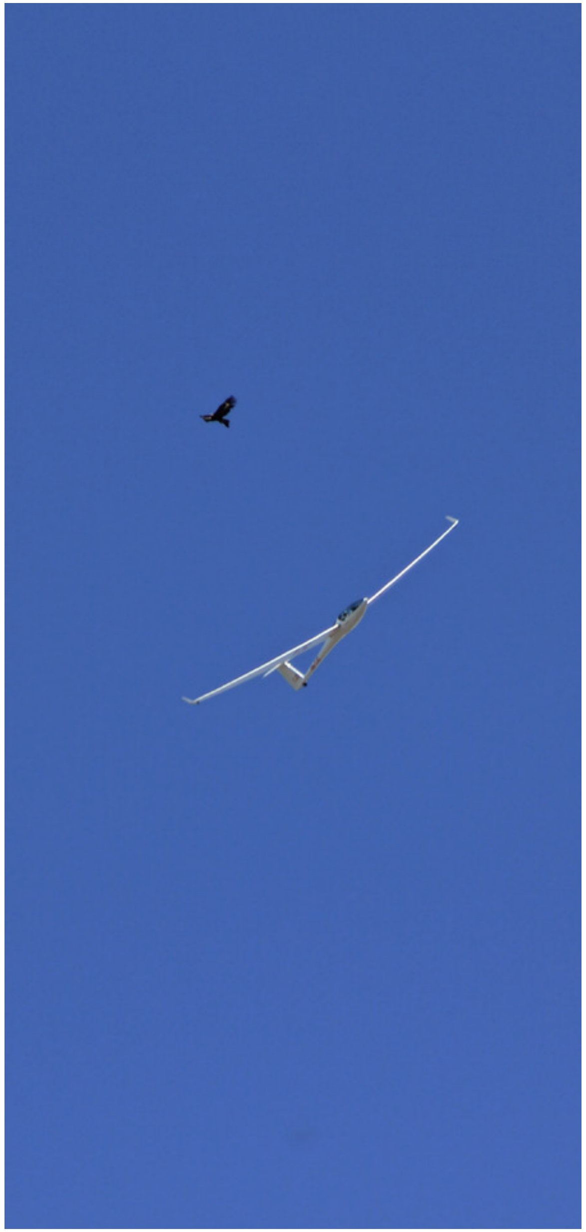
A big wingspan can be more of a liability when launching. A dropped wing, especially in long wet grass, will stop a wingtip much faster so there's a greater risk of ground looping. This means that you have to be very alert to a wing drop in the early stages of launching, especially when winch launching, so be ready to release immediately.

The cockpit is often smaller in a high performance glider, narrower and shallower. If you're used to taking a camera, a water bottle and some food up with you, as well as a watch and wallet, don't try this in a high performance glider without checking each item first to make sure you have room.

In some gliders, you cannot retract the undercarriage if you're wearing a watch or have a wallet in your pocket because the cockpit is so narrow. These gliders may be able to carry 150 litres of water but there's very little space for drinking water in the cockpit.

Strength. High performance gliders are built to the same design rules as any other glider and are quite strong enough for their intended use when flown by competent pilots. That probably means that the undercarriage is not as strong as one on a training glider.

None of the above factors should discourage anyone from flying a high performance glider. In every respect, they're the thoroughbred of the air, the pinnacle of aerodynamic achievement. Sure, some heroes have flown 750 km in training gliders but it's far easier in a high performance glider!



Using Water Ballast

Water ballast is used to increase the cross country speed of a glider by increasing the wing loading. This has the effect of moving the glider's polar curve to the right. While stall speeds and min sink speeds are higher, the L/D curve is flatter at higher speeds.

Or course the glider will also climb more slowly in thermals but on a strong day, water ballasted gliders have a big advantage over unballasted gliders.

If you want to fly with water ballast, discuss this with an instructor or the club's CFI. Fly a glider that you're already familiar with in which you've had enough launches, landings and air time. Talk to more experienced pilots who fly the same type of glider.

Overall, there shouldn't be a big change in the way the glider handles but launch speeds will be higher and so will thermal speeds and you must dump water before landing. There's a bit to think about so be cautious as always.

Always read the glider's flight manual before using water ballast. Many are light on details but there are often a few essential comments worth reading.

Modern gliders are often designed to carry a large weight of water, at least 50% of the airframe weight or over 150 litres. Water is carried in the wing in front of the main spar in the D section of the wing. Because this is ahead of the centre of gravity, there's often a tail tank to balance the load.

Filling water ballast tanks

Water in the wings can be contained in bags or integrally in the wing structure. Baffles are used to limit lateral flow of the water.

Water tanks can be filled with a container of known volume or with a hose and funnel. Never put a hose connected directly to a tap into a wing tank opening, the pressure can easily split a wing structure. Fill a funnel with a short length of hose connected to the wing tank with a maximum of 1 metres head so any excess can overflow.

Digital flow gauges for water and fully automated devices specifically intended for gliding use are available from the internet for faster and easier ways of adding water. It's a good idea to check the calibration on water meters by filling a bucket.

Make sure the amount of water is the same in each wing and that the wings balance. Make sure that the wing and fin tank dump valves work properly and are not leaking. Leaky valves can lead to an asymmetric wing loading which could cause big problems on takeoff and in the air.

It's a good idea to check the time taken to dump a bucket-full of water so you can dump a known amount of ballast in-flight if needed and also how long it will take to completely dump the water ballast. Check that both wing dump valves drain at similar rates.

The tail tank should be dumped in sync with the wing tanks. Most cockpit dump valve controls are set up to make sure the tail tank valve is opened at the same time that the wing tanks valves are opened.

Before Launch

Towing a glider with water can be tricky – particularly traversing sloping ground. If the wing walker is on the uphill side, water may run downhill in the lower wing, resulting in that wing scraping along the ground. The wing walker may not be heavy enough to keep the wing down, so hang a couple of old bottles of water in a shopping bag from the wing walker to hold it down.

Tow out slowly and keep a good eye out behind to make sure a wingtip has not dropped. Tufts of grass can easily damage ailerons and hinges.

The glider's wings should be held level at the launch point and the usual way is to have a couple of sticks with rubber ends propping up the wings. Extendable poles can be bought from paint shops and ironmongers which work well.

If you don't have sticks, keep the wing walker on until launch, and persuade your wing-man to manage the wing walker after you've launched.

Launching with Water

Don't be too concerned about your first flight with water. Some pilots advise making your first flight half full, but you'll find the glider quite manageable full of water. It feels more solid in the air, it doesn't get bounced around as much, and the glider is just as easy to handle full as empty, *provided you fly a bit faster*.

Make sure your wing runner balances the wings before the tug starts to roll. If the wings are not balanced, when the wing runner lets go you'll have trouble holding that heavy wing up until you get full aileron control.

If the wing runner has your wings properly balanced before you roll, the inertia in the wings keeps them more stable than with an empty glider, and the launch is easier to control.

You'll need to aerotow at a higher speed. A fully ballasted 18 metre glider gets quite mushy and uncomfortable aerotowing at 60 knots.

If you're heavy, make sure the tuggie knows, and request a 70 knot tow. If on tow out you're not getting that speed, quickly request "plus 5/10 knots." Don't ask for 70 knots – the tuggie may already think they're flying at that speed, or the ASI may be over-reading – always say "plus" whatever you need.

Aerotow with high take-off weight requires a powerful tow plane. Many tow planes are not certified to tow gliders with high take-off weights. Reduce the take-off weight if necessary!

On the winch, a fully ballasted single seat glider all-up-weight won't be too different to that of a two seater trainer, so a winch with enough power to launch the training gliders should be able to handle a ballasted single seater.

However, the stall speed when ballasted is appreciably higher than for an empty glider and the minimum winch launch airspeed needs to be adjusted upwards - (1.3 x Vs min.).

Self-launching with ballast

Modern self-launchers can often carry about one and a half times the pilot's weight in water. This means that the glider is going to take a lot longer to lift off… on a typical 30° summer day, the takeoff roll is about 70% longer. On a very hot day, even further than that.

Check the flight manual for information on flap position. On gliders which are happy to take off with positive flaps, it may be recommended to use 0° or negative flaps on the initial part of the take-off roll and move to positive flaps when you have aileron control authority

Flying with Water Ballast

As a rule of thumb you can expect to achieve another 10% in cross country speed on a reasonable day. You should cruise about 10 knots faster between thermals. You'll need to fly faster when thermalling. Your glider will feel more solid and secure in bumpy air. If you have to dump water you'll be surprised at how light, jumpy and twitchy an empty glider feels in comparison to what is was like full.

Remember that stall speed increases with wing loading – the whole polar curve shifts right. In an 18 metre glider with a best L/D at 50 knots empty, you'll need to fly at 65-70 knots fully ballasted. You may find that an empty glider thermals best at around 50-52 knots, the same glider will require as much as 60 knots when climbing full of water.

OAT

Watch the outside air temperature when flying with water ballast. Under no circumstances should you carry water if the outside air temperature is close to freezing. Many flight manuals recommend dumping water when the OAT is +2ºC.

Never leave the glider or park it outdoors if there is a risk of low temperatures.

Aerobatics

Gliders may be approved to do simple aerobatics when not full of water, but most are not approved to do so when water ballasted. Read the flight manual… "Intentional spins with water ballast are not permitted."

When to Dump Water?

In Australia in summer we're blessed with strong conditions, and rarely do experienced pilots take off without full water ballast. In comps, it's always an advantage to stay full, at least until you reach the first thermal on track. If it's a very weak day, you can dump then… you've had the benefit of the flatter first glide to that thermal.

Some recommendations for older gliders suggest that ballast is not worthwhile unless conditions exceed 4 knots for the day and many of us tend to hang on to water ballast for far too long. The decision to dump fully or partially to reduce wing loading depends a lot on your view about how conditions will develop, and also how well your glider climbs when heavy.

While on the ground, you should have checked the rate of water flow out of the glider with the dump valves open, remembering that in-air the flow rate could be different. In straight flight the air pressure under the wings is higher than above, and flow is probably slower, while in a steeply banked thermal with extra G forces the glider probably sheds water faster.

Typically, tanks will empty in around 4-5 minutes – some dump much faster than this. If you're having trouble climbing try dumping half your water. Maybe a minute with taps open and see how it "feels" before getting rid of it all. Normally, the tail tank empties at a rate which keeps the glider in balance but make sure the tail tank dump valve is open at the same time as the wing valves.

Remember thermalling etiquette – don't dump on top of other gliders thermalling below.

Remember to dump water ballast completely before landing, normally opening the taps on final glide at around 15 km from home.

Landing with Water

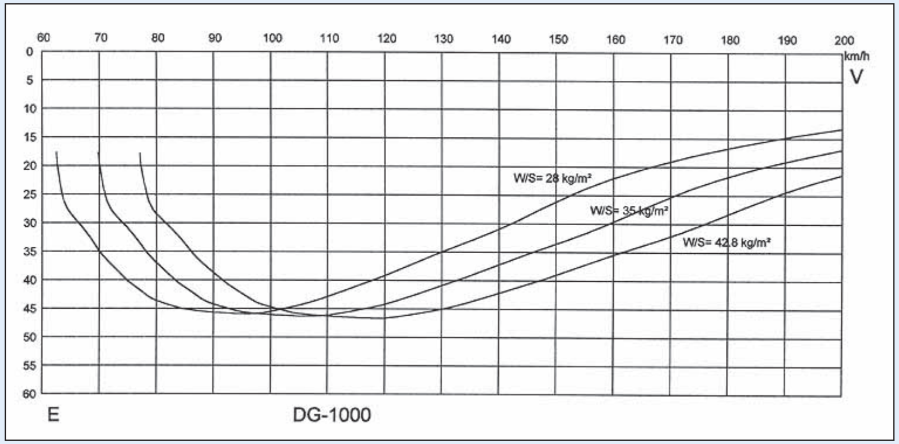
Most manufacturers don't recommend landing with full water – but if you need to, remember extra speed, at least another 10 knots over normal approach speed and a gentle round-out.

Flaring the glider at normal approach speed with a heavy glider can give a nasty surprise – the glider doesn't respond to the flare the same way and you may have a heavy landing.

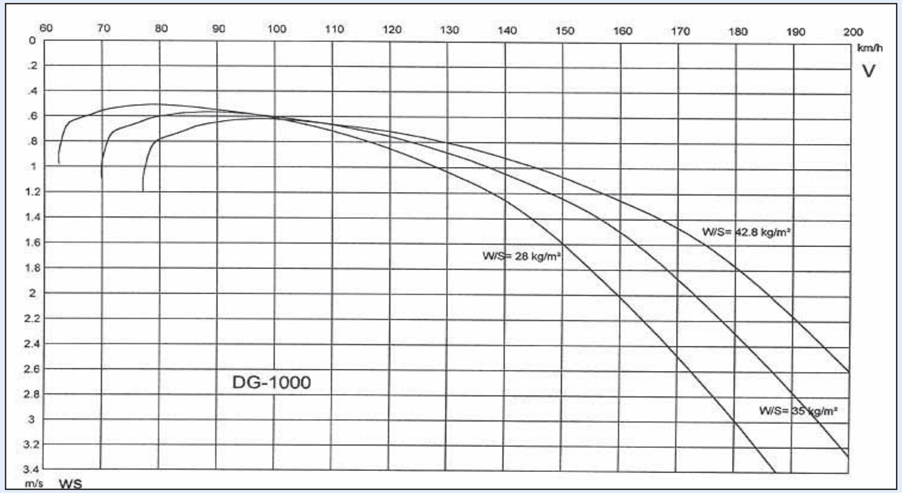
You must have extra speed so that the glider will respond at the flare and the stall speed is around 10 knots higher, so touchdown will be correspondingly higher. This can be much harder on the undercarriage.

The Polar Curve and Water Ballast

The graph below shows a glider's L/D or glide radio at various wing loadings. The best L/D is the same for different wing loadings, but it occurs at different speeds. The higher the wing loading, the higher speed. You can also see that the Vs speed is higher at higher loadings.



The next graph shows the polar curve: You can see that the minimum sink rate occurs at lightest wing loading. The heavier the loading, the longer you'll have to circle in the same thermal for a given height gain.



Higher wing loading is a trade-off between higher average speed and less efficient climbing. In the case of strong thermals and/or long glide intervals, the optimum moves toward more ballast and in weak conditions towards less or no ballast.

The good thing is that you can dump water quite quickly, partially or fully, so that in a competition you usually fill up before takeoff and dump if necessary rather than start light.

Aft ballast in the fin is sometimes used to balance a forward centre of gravity caused by water in the wings ahead of the main spar. Depending on your glider, partial dumping can be problematic unless the dump valve control is designed so that the tail water tank is dumped in sync with the wing tanks.

Problems dumping water

If you suspect that the water ballast isn't dumping symmetrically (typically by the position of the stick at low airspeeds) you must close the dump valves of the wing tanks immediately, to avoid greater asymmetry.

When flying with asymmetric water ballast you have to increase the airspeed, especially in turns, so that you can avoid a stall at all costs. A fully developed spin may not be recoverable with asymmetric load.

Fly the a normal circuit and touch down about 6 knots faster than usual and after touch down, carefully control the bank angle to avoid a wing touching the ground too early.

It is dangerous to fly with empty wing tanks while ballast is remaining in the fin tank because the CofG position might get dangerously aft, therefore it is prohibited to put water in the fin tank if there is any risk of icing.

If the operating force of the fin ballast control handle is unusually low (you don't feel the force of the retaining spring) you should suspect that the valve cannot be opened. In this case you should shut all the valves, wings and tail, to avoid an inadmissibly aft CofG position.

If you must perform a landing with full ballast, try to avoid an outlanding. (That's verbatim from a flight manual!)

Leaky dump valves – often a problem. Drip, drip, drip. Try a bit of Vaseline around the rim of the valve seat. But be careful. Some dump valves rely on rubber to seal, and grease (to a lesser extent Vaseline) can degrade the rubber.

Neoprene is more resistant to grease. Silicon grease won't worry rubber seals. Some dump valves have a threaded centre into which you can screw a tool to pull down more firmly and improve the seal before launch. If you partially dump water during the flight, the valves may still drip in air.

Always check before launch that both wings are dumping water evenly. If you suspect they're not in flight, add another 5-10 knots to your approach speed when landing, and prepare for a ground loop at the end of your ground roll as you lose speed.

In the air, it's probably a good idea to consciously maintain a bit extra speed as a spin with asymmetric wing loading could be unnecessarily exciting.

Bags & Integral Tanks

There are potentially some problems with integral tanks where the wing structure forms the tank. Composite resins, and gelcoat absorb water and ultimately can deteriorate and weaken with water penetration.

The inside of the tanks may be sloshed with paint or gelcoat during the manufacturing process to provide a water seal at the spar/skin joints. How well this seal withstands continual moisture is unknown. Some gliders are known to have developed leaks and water penetration into the structure.

It is recommended that gliders be stored with water dump valves open to allow residual water to dry out – some people have installed small fans to aid the ventilation when hangared.

Water bags contain the moisture inside a plastic sleeve which protects the integrity of the resin structure, but bags can also develop leaks, and the vinyl deteriorates with age and need repair or replacement.

Fortunately, there are a number of Australian companies which can supply good new water bags for a lot less than OEM bags.

Gliding Simulators

Simulators are being used for training in all sorts of fields, especially in aviation where flight trainers have been around for at least 80 years. It's been shown that properly used, simulators can be a great addition to glider training.

There are reports of students going solo after a handful of flights in a real glider with the balance spent flying simulators. In one case the instructor and the student work on-line and don't have to be in the same room.

There are things which you can do in a simulator which you cannot do in a real glider… apart from being able to fly at night and when it's raining and windy outside.

For a start, you can stop a flight in midair and discuss anything from the terrain and outlandings to circuit patterns and emergencies. You can record and replay flights to highlight events and actions which can be forgotten about in a live flight.

Simple but essential basics such as situational awareness can be taught and reinforced very easily in a simulator. The use of simulators is so obviously a potential way of offering a cheaper and faster way of getting into gliding that the GFA and many gliding clubs are actively supporting building or evaluating simulators.

Oddly, a gliding simulator does not have to be complex and expensive. It's been found that even the most basic simulator has a lot to offer while those which go some way to duplicating a glider's cockpit and controls are even better. It's not necessary or even a good idea to have a simulator which is motorised so the fuselage moves and in fact these have been shown to quite effectively induce air sickness.

There are some things which simulators don't do perfectly. Most simulators do not have any feedback from the controls… they don't stiffen up when flying fast or give feedback of things like pre-stall buffet. The screen resolution is not quite good enough to give you the complete cues as to your height so the first few feet of a launch and the final few feet of a landing are a bit vague.

There's no 'G' feedback so thermalling, side slipping, stalls and spins lack realism.

That does not mean that simulators are not a very effective tool for launch training and circuit planning and flying right down to chair height. Many clubs are already factoring simulators into their programs

Most current simulators run on low-cost commercial software running on a reasonably priced computer and use one or more large screens or projectors, often with separate displays for the cockpit instruments, a setup which is remarkably convincing.

The software side of gliding simulators is a little complicated. There are three or four programs which are either dedicated gliding simulators or programs which have a library of gliders. Each has merits and disadvantages. For example, winch and tow launch emergencies are handled in some programs well.

In one program, you can vary the tow cable length and get realistic bows and jerks in the cable as it tightens. In another, the instructor can steer the tug to give the student a more interesting tow.

In some programs, the scenery can be edited to allow clubs to accurately recreate or augment the scenery of their own airstrip, including adding hangars and buildings as well as planting trees in the right places.

The only gloomy note is that at the time of writing, there's not one single standout piece of software and because all the programs are relatively low-cost, there may not be enough of an incentive for develops to improve the software. It's to be hoped that internationally, gliding clubs see the value of accurate simulator software and get behind one or other programs to ensure it's continuing development.

Virtual or augmented reality gliding software with accurate landscapes and weather engines is, at the time of writing, a bit of a dream.

There's no doubt that for the pilot, a VR headset makes flying look incredibly realistic but because the glider's controls are not fully matched in the headset view, the pilot see's what appear to be someone else's hands operating the controls.

When one pilot is wearing a VR headset, nobody outside can see what they're doing unless they have external monitors or a second headset. If the instructor wears a slave headset, they can get airsick very fast because they have no feedback from any controls.

With so much money being put into VR and augmented reality it may be that the future of gliding simulators involves either of these technologies, alone or combined with the real fuselage assemblies of more conventional simulators.

If you have the opportunity to try a gliding simulator, it's well worthwhile, especially while doing basic training. If you live in a region where you can't fly all year round, then a few simulator sessions can help to keep you current.


UHM

Further Reading

Where do you want to go from here? Hopefully, you will want to know a lot more about gliding and most of the good stuff can be found in books. The books fall into three loose categories, books about gliding technique, books about history and books about the people and sport of gliding.

Some of the better books are out of print but most can be bought second hand using the various internet book suppliers.

The Story of Gliding. Ann Welch. ISBN 0-7195-3659-6

One of the best books ever written about gliding. The reason why is that almost every chapter makes you want to jump in a glider and fly. It was published in 1980 so the story stops there. Perhaps you will continue it?

Advanced Soaring Made Easy Bernard Eckey ISBN: BK-3-98088382-5

This is a comprehensive and up-to-date book which covers the whole spectrum of gliding from flying to meteorology and mental preparation.

Competing in Gliders L Brigliadori ISBN-10: 8875110581

This book is written by two top competition pilots and firmly aimed at the competition pilot. It's got some great personal stories and tips.

Cross Country Soaring H Reichman ISBN-10: 1883813018

For years, this was the essential book to read if you wanted to improve your gliding skills. A little dated in places but essential reading.

Model Aircraft Aerodynamics Martin Simons ISBN-10: 1854861905

Forget about the word 'model", this is probably the easiest to read and most comprehensive book on aerodynamics. All you need to know.

On Being a Bird Paperback Philip Wills ASIN: B0030HVFEA

Nobody wrote about gliding as well as Phillip Wills. Part history and part technique. This is the book to give someone to explain why you go gliding.

The Art of Soaring Flight Wolf Hirth

Published in 1938, this book tells the story of the pioneering years in Germany and the USA and the discovery of thermals and wave lift.

Winning on the Wind George Moffat ASIN: B000MQPXPE

Part technique and part story, multi-world champion George Moffat explains in simple and easy terms, how it is done. Dated but great.

And of course there's the internet. A magnificent source of all knowledge and stupidly carefully blended together.

Acknowledgements

This manual was never intended for gliding instructors but of course it could not have been written without them.

All of us who fly sailplanes must owe a huge debt of gratitude to our instructors and coaches and certainly I do. Every one of them. The words here are the words of all my instructors, the printable words anyway…

From Trevor and Allan who both used many of the unprintable ones when discussing my flying abilities, to Gerhard who quietly sat in the back of the K21 and read the flight manual. He told me the official version of every lesson, and then followed it up with his own funnier version. Dave told me "left wing down" so I put it down but what he meant was that the left wing was down, could I please lift it up.

Jenny stoically put in the hours until she could not stand it any more and gave me to John for remedial flying and in my most memorable training flight, he directed us into the downburst of a black, rain filled cloud to show that it wasn't a CuNim. And we only just made it back to the strip in time to avoid a real one.

And then, one shining day, even I was deemed fit to go solo and I have never regretted the struggle to get that far.

There are many legends in gliding and Ian 'Macca" McPhee and Garry Speight are up there with the best. I hope I have reproduced their lessons correctly here. From Macca, I learned a lot, including that two blokes wearing Blundies should not attempt a simulated engine failure without first checking that they can make a sharply banked turn back to the strip without one bloke's boots getting in the way of the other bloke's boots and jamming the rudder pedals.

From Garry, I learned so much of what is written here, but mainly to never give up. I listened to him one day struggling to stay airborne for 45 minutes and finally radio to say that he was back at cloud base and not to be beaten, he was going round the task again.

And finally, a huge debt of gratitude is owed to Professor of Pedantry, Laurie Hoffman and Chris Thorpe. They can proof read well enough but they can sure be picky… and how they can nag… and move the goalposts.

Hopefully my debt of gratitude will be paid back by anyone who reads this book and gets enough out of it to learn to fly and love flying sailplanes.

Have fun, stay safe!

JC 2016

The section on water ballast was largely done by Dave "Fill 'er up" Shorter.

The vast majority of the photographs were taken by Geraldine Clark, one of the few people to refuse to get on board a perfectly airworthy Qantas Dash 8. Which means that the airborne pictures were initially taken under some duress. The cockpit pictures were mainly taken by the camera itself.

Abbreviations and Acronyms

Since Otto Lillienthal first stepped off a hill, aviation has been plagued by abbreviations and acronyms. In the world of general aviation, there are over 30 abbreviations with the letter A.

In the interests of clear and concise communication, it's suggested that you resist the urge to abbreviate important words more than necessary.

Abbreviation or acronym	Translation
AAA	Amended meterological message
AAAA	Aerial Application Association of Australia
ABN	Aerodrome beacon
ABN	Australian Business Number
ABT	About
ABV	Above
ACAS	Airborne Collision Avoidance System
ACN	Australian company number
ACT	Active, activated, activity
ACT	Australian Capital Territory
AD	Aerodrome
AD	Airworthiness Directive
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-B	Automatic dependent surveillance-broadcast
AFIS	Aerodrome flight information service
AFRU	Advance Flying & Refresher Unit
AFRU	Aerodrome Frequency Response Unit
AFZ	Australian fishing zone(s)
AGD	Attorney-General's Department
AGL	Above ground level (height vs altitude)
AIP	Aeronautical Information Publication
ALA	Aircraft Landing Area
ALA	Alighting area
ALA	Authorised Landing Area
AMSL	Above Mean Sea Level
AN	Airworthiness Notice
ANC	Aeronautical Chart 1:50,000
ANC	African National Congress
ANO	Air Navigation Order

AO	Air Operator
AOPA	Aircraft Owners and Pilots Association
AR	Aspect ratio
ARFO	Area Forecast
ARVO	Afternoon
ASA	Australian Skydiving Association
ASAP	As Soon as Possible
ASI	Air speed indicator
AT	At
ATC	Air Traffic Control
ATIS	Automatic terminal information service
ATIS	Automatic Terminal Information Service
ATS	Air Traffic Services
ATSB	Australian Transport Safety Bureau
AVGAS	Aviation piston engine fuel
Best L/D	Best lift/drag. Airspeed at which glider will fly the longest distance for the least height lost.
CAO	Civil Aviation Order

CAR	Civil Aviation Regulations
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulations
CofG	Centre of gravity
COTS	Consumer Off The Shelf Device
CROC	Critical rate of climb
CTAF	Common Traffic Advisory Frequency
CU	Cumulus cloud
EFB	Electronic flight bag
ERC	En-route Chart
ERC-LOW	En-route Chart Low
ERSA	En-route Supplement Australia (CASA)
FLARM	Flight alarm (proprietary name)
FROL	GFA Radiotelephone Operator Authorisation
GA	General aviation
GFA	Gliding Federation of Australia Inc.
GPC	Glider pilot certificate

GPS	Global positioning system
IAS	Indicated air speed
IFR	Instrument Flight Rules
L/D	Lift/Drag ratio.
LCD	Liquid crystal display
Min. sink	Minimum sink. Airspeed at which glider's sink rate is at its minimum.
MOGAS	Petrol as used by wheeled motor vehicles
MOSP	Manual of Standard Procedures (GFA)
NAIPS	National Aeronautical Publication Service
NIS	NAIPS Internet Service
NMA	Non-manoeuvring area
NOTAM	Notices to airmen (CASA)
Op Regs	Operational Regulations (GFA)
PED	Personal Electronic Device
PMG	Postmaster-General's Department
PTT	Press to talk (on radio)

QFE	Mean sea level atmospheric pressure adjusted for a specific site (e.g. an airfield). When set on an altimeter at that site, it will show zero. After take off it will show height (not altitude) above ground level at that site (AGL). At a different site with a different altitude and/or different QFE, the altimeter will have to be reset to that site's QFE if the altimeter is to read zero at that site.
QNH	"QNH derives from Q codes (QAA-QNZ) where Q stands for Question. Sometimes said to equal Query: Nautical height. The atmospheric pressure measured at a site then reduced down to mean sea level pressure. When set on an altimeter at that site it will show the altitude (i.e. above sea level; not AGL, above ground level) of that site. Cp QFE.
R/C glider	Radio controlled glider
RAAus	Recreational Aviation Australia (was Australian Ultralight Federation)
RPT	Regular passenger transport
SAR	Search and rescue
SLG	Self-launching glider
TAF	Terminal Area Forecast
TAS	True air speed

TMG	Touring motor glider
Va	Maximum manoeuvring speed smooth air
Vb	Maximum manoeuvring speed rough air
Vd	Dive speed
VFR	Visual Flight Rules
VNC	Visual Navigation Chart
Vne	Maximum speed for all operations (never exceed speed)
Vra	Speed range in which manoeuvres must be conducted with caution and only in smooth air
Vs	Stall speed
VTC	Visual Terminal Chart
WAC	World Aeronautical Chart

Index

M

N

O

P

Q

R

Y