[X-TEAM]

X-Team Pilot Training Manual

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Record of Revisions

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Revision Highlights

Please read the revision highlights below when you insert revised page onto Nisleg-Center Air Field Operation Manual.

PART	PAGES	REVISION No.	REVISION SUMMARY

List of Distributions

Assignment	Control Number
MCAA	1 (HARD)
Main Office	2 (HARD)
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Abbreviations

A.I.C	Air Information Center
AIS	Aeronautical Information Service
A.I.P	Air Information Publication
AGL	Above Ground Level
ATC	Air Traffic Control
CB	Circuit breaker
CFI	Chief Flying Instructor
DA	Descent Altitude
DI	Duty Instructor
Ft	feet
HQ	Head Quarter
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Requirement
IMC	Instrument Meteo Condition
Km	kilometer
Kts	Knots
m	meter
MCAA	Mongolian Civil Aviation Authority
MCAR	Mongolian Civil Aviation Regulation
MDA	Minimum Descent Altitude
Min.	Minimum
MSL	Mean See Level
NIL	Not Illegible
No.	Number
NOTAMS	Notification To Air Man
NW	North West
OA	Operations Assistant
QFE	Setting to give height above Aerodrome
QNH	Regional Pressure Setting"
Rwy	Runaway
SE	South East
VFR	Visual Flight Requirement
VNC	Visual Navigation Chart
VMC	Visual Meteo Condition
X-Team	

Introduction

This Training Manual has been put together by the X-Team Flying Club of Mongolia to assist those who wish to fly these remarkable aircraft and to enjoy the sport safely and with confidence.

Flying any type of aircraft, including the microlight, carries with it critical responsibilities. The pilot is responsible for not only his or her own safety but for the safety of his or her passengers and the public at large. There are also other matters to consider such as avoiding causing nuisance, respect for property and the rights of others. As a potential operator it is necessary to understand and subscribe to these responsibilities so that the reputation of the Association and its many members continues to enjoy the respect of the Mongolia public and of the international microlight fraternity.

The material contained in this manual was not prepared for the casual reader. It should be read with the intention of learning it and putting it into practice. Knowing what is contained in this document may well save lives.

Microlighting has come a long way in the past twenty years or so and the publication of this manual is another step towards the goal of safe, relatively cheap flying for those enthusiasts wishing to enjoy what has been described as the most enjoyable way to experience the freedom of safe flight.

I commend it to all microlight pilots and I congratulate the X-Team on producing it.

CEO ………………………… Alexandr Amia

1. Principles of flight

Forces acting on the microlight

A microlight in flight has following four forces acting upon it:

- **WEIGHT,**
- **LIFT,**
- **THRUST,**
- **DRAG**

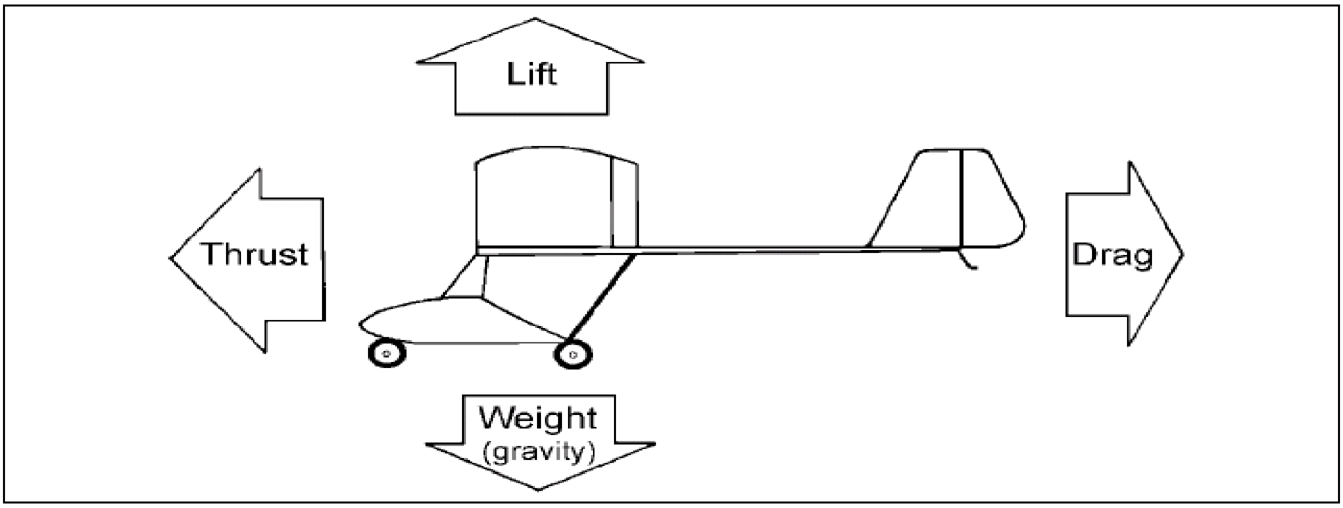

Fig. 2 The four forces acting on an aircraft in flight.

- Weight: Acts vertically down (gravity) and has to be overcome by a force acting vertically upwards so that flight may be sustained. It is basically constant in flight except for a decrease taking place with the usage of fuel.
- Lift: Acts upward to overcome weight. It will vary according to airspeed and/or angle of attack. It acts at right angles to the airflow but not necessarily in exact opposition to weight when out of level flight.
- Thrust: Produces the forward movement which provides an airflow over the wing. It will vary according to the power applied and/or the angle of attack.
- Drag: The force which tends to hold back or resist forward movement. Thrust varies with airspeed and angle of attack and acts in opposition to thrust.

During straight and level flight at a constant speed LIFT equals WEIGHT, THRUST equals DRAG, and the aircraft is said to be in equilibrium.

Any inequality between lift and weight will result in the microlight entering a climb or descent. Any inequality between thrust and drag will result in acceleration or deceleration. Before discussing these four forces further, let us examine some of the terms used extensively in this section.

Airfoils

An airfoil is a device which gets a useful reaction from air moving over its surface. When moved through the air it is capable of producing lift. Wings and propellers, horizontal and vertical tail surfaces are all examples of airfoils. For convenience we will use a cross sectional view of a wing in our discussion. Microlights can have either a single surface or a double surface wing as drawn in cross section following. However, for our purposes we will use a double surface airfoil. See Figure 3.

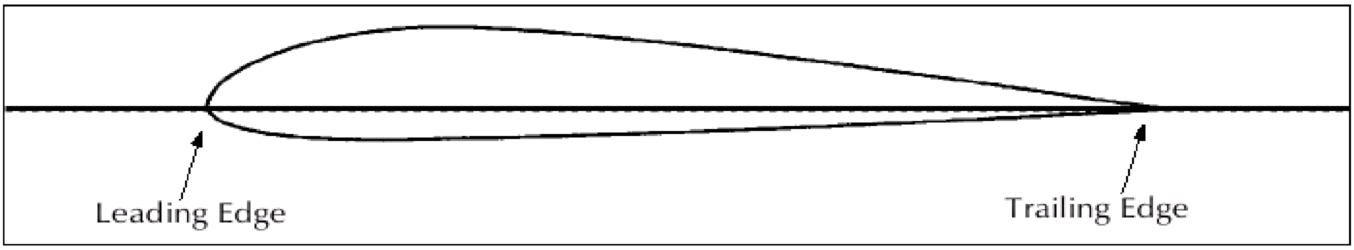

Fig. 3 Cross-section of a typical airfoil with chord line.

The forward part of an airfoil is rounded and is called the leading edge. The aft part is narrow and tapered and is called the trailing edge. A reference line often used when discussing airfoils is the chord line. The chord line is an imaginary straight line joining the tips of the leading edge and the trailing edge.

Angle of Incidence

The angle of incidence (see Figure 4) is the angle formed by the chord line and the longitudinal axis of the microlight. The longitudinal axis being an imaginary line running lengthways through the machine from nose to tail. The angle of incidence is not usually able to be changed by the pilot.

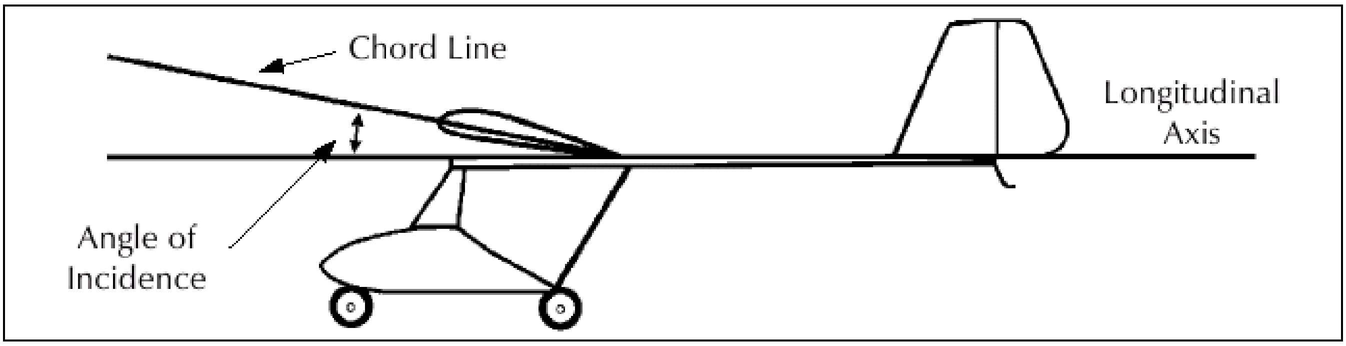

Fig. 4 Angle of Incidence.

Relative Wind

The relative wind is the direction of airflow in relation to the wing. If, for example, a wing is moving forward horizontally, the relative wind moves backwards horizontally. If a wing is moving forward and upward, the relative wind moves rearward and downward. Thus the flight path and relative wind are always parallel, but travel in opposite directions. See Fig. 5. A microlight moving through the air has relative wind, just as does a microlight stationary on the ground with the wind blowing over it.

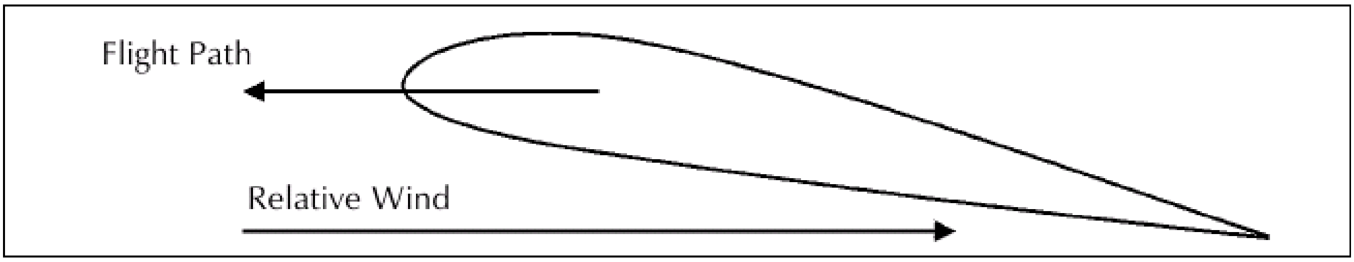

Fig. 5

Angle of Attack

The angle of attack is the angle between the direction of the relative wind and the chord line of the wing, (or between the flight path and the chord line). See Fig. 6. Do not confuse angle of attack with the angle of incidence. The angle of incidence is normally fixed, but the angle of attack may be varied by the pilot and is relative to the flight path.

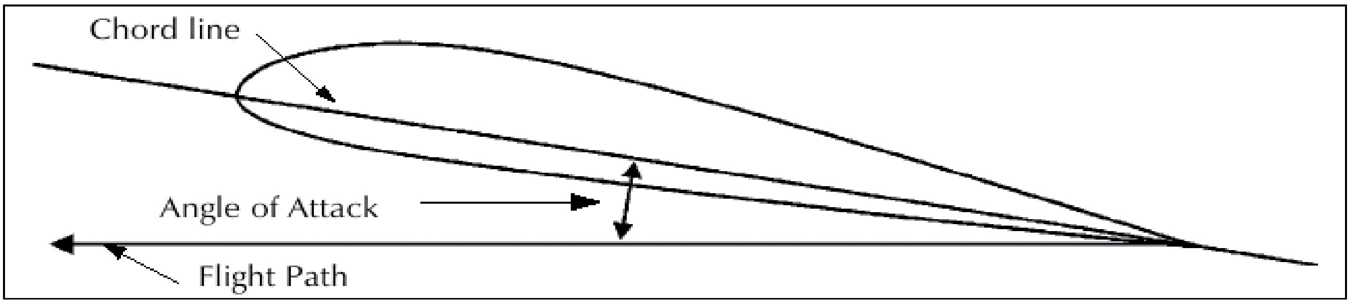

Fig. 6

Bernoulli's Principle

Many years ago the scientist Bernoulli discovered that the pressure of a fluid (liquid or gas) decreases at points where the speed of the fluid increases. This simply means that highspeed flow is associated with low pressure and low speed flow is associated with high pressure This principle has particular application to airfoils, which are designed to increase the velocity of the airflow above their surfaces. This decreases the pressure above the airfoil. At the same time, the impact of air on the lower surface of the airfoil increases the pressure below. It is this combination of decreased pressure above and increased pressure below which produce lift. Approximately 80% of lift is produced by the TOP surface. See Figs. 7 & 7a.

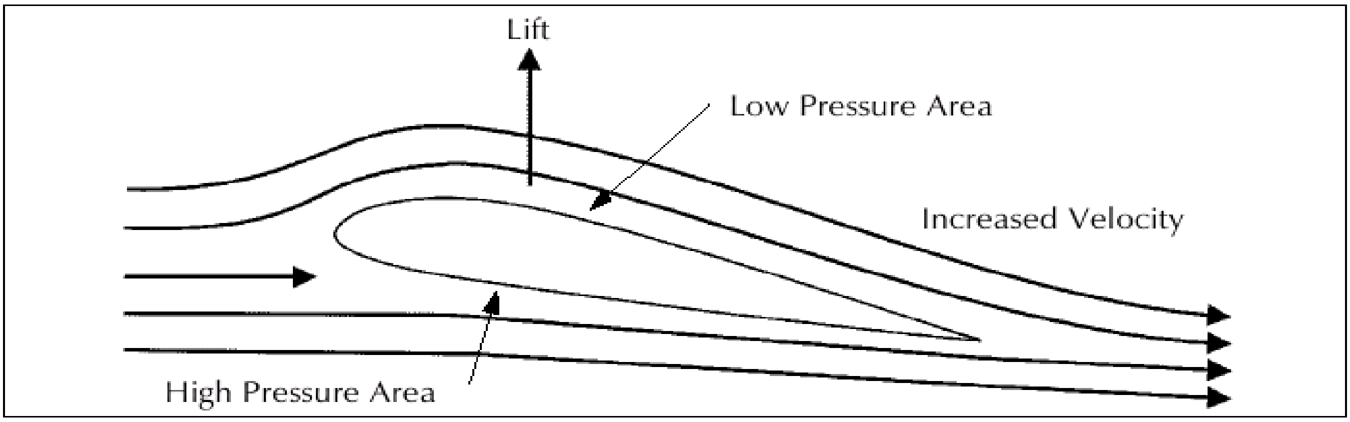

Fig. 7

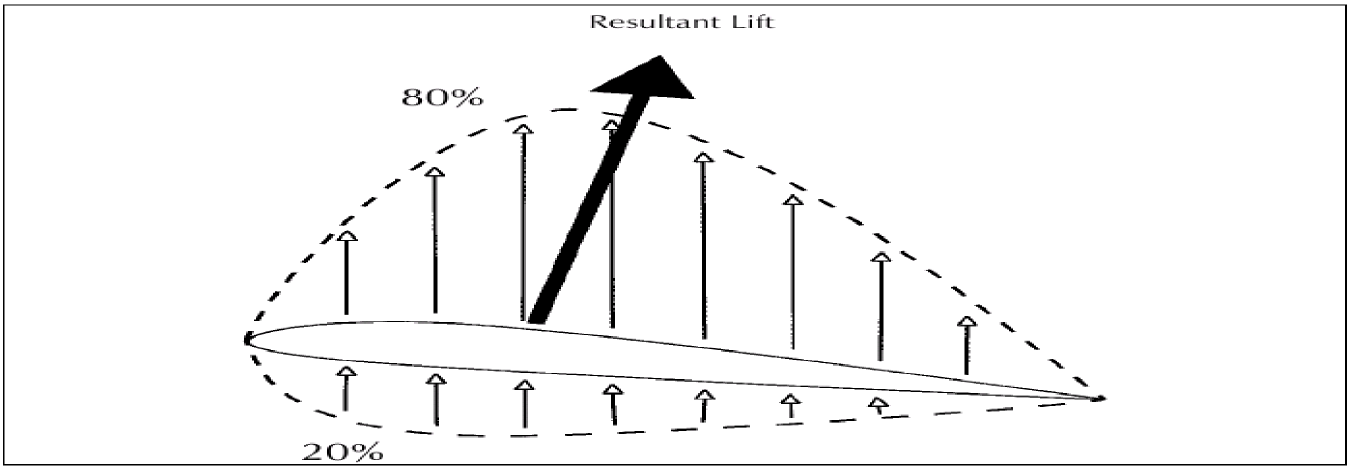

Fig. 7a Lift distribution Upper and Lower surfaces.

Lift

We have already mentioned that it is the airflow over the airfoil which produces the lift. The upward component of this force is lift, but during its production there is a rearward component and this is induced drag. See Fig. 8.

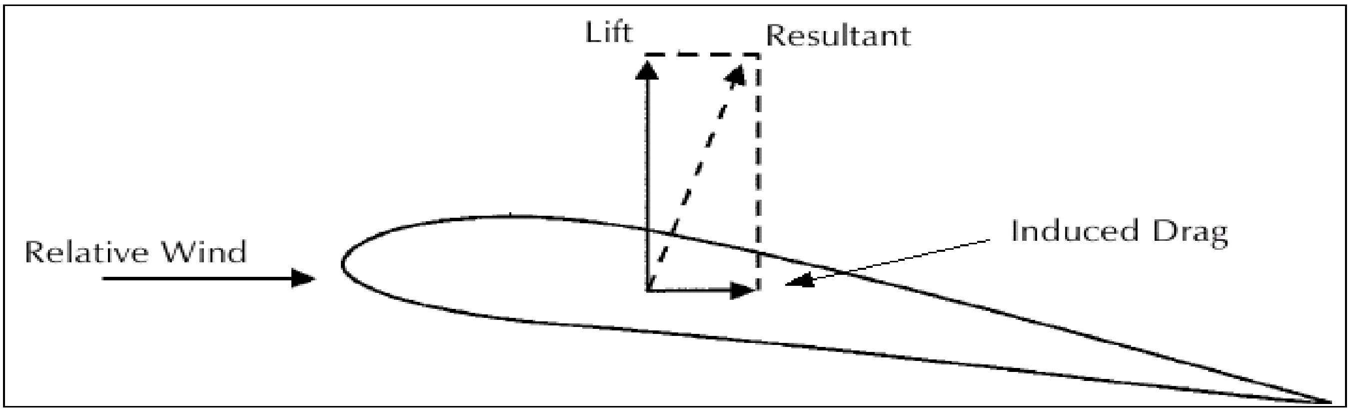

Fig. 8

Drag

The total drag of a microlight, as shown on the four forces, is actually made up of two types of drag: Profile or Parasite Drag and Induced Drag.
Profile Drag is simply the drag created by the form itself of the microlight airframe, undercarriage, rigging, etc. As the speed increases, profile drag increases sharply. In fact, if the speed is doubled the drag is four times as much as for the previous speed.
Induced Drag is a result of the production of lift by the wings/airfoils. At high angles of attack the induced drag is high. At low angles of attack the induced drag is low. The use of streamlining of the airframe results in significant reductions in parasite drag, but reduction of induced drag is more difficult.
Briefly, long slender wings (high aspect ratio) such as found on sailplanes minimise induced drag. Wide chord wings of short span (low aspect ratio) produce more induced drag. See Figure 9.

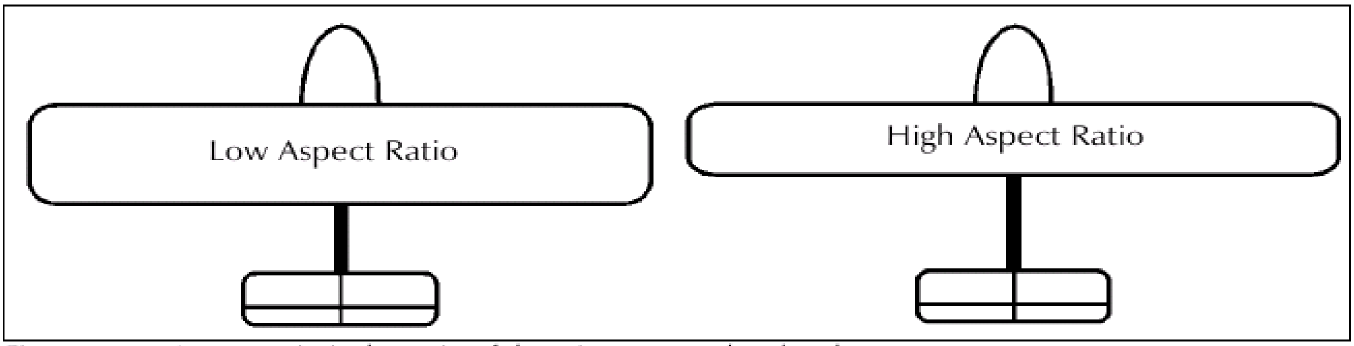

Fig. 9 Aspect ratio is the ratio of the wingspan to the chord.

Relationship between Lift and Angle of Attack

As mentioned before, the angle of attack is the acute angle made by the chord line of the wing and relative wind or flight path. At small angles of attack there is a small differential between the increased pressure beneath the wing and the decreased pressure above the wing.
By increasing the angle of attack, the effective camber (curvature) of the wing is increased. Thus the air is required to travel a greater distance in the same time. In order to travel this greater distance, Bernoulli's Principle tells us it must accelerate, producing a greater decrease in pressure. So, increasing the angle of attack results in an increased pressure differential, meaning greater lift. It also results in increased induced drag. See Figs. 10a &10b.

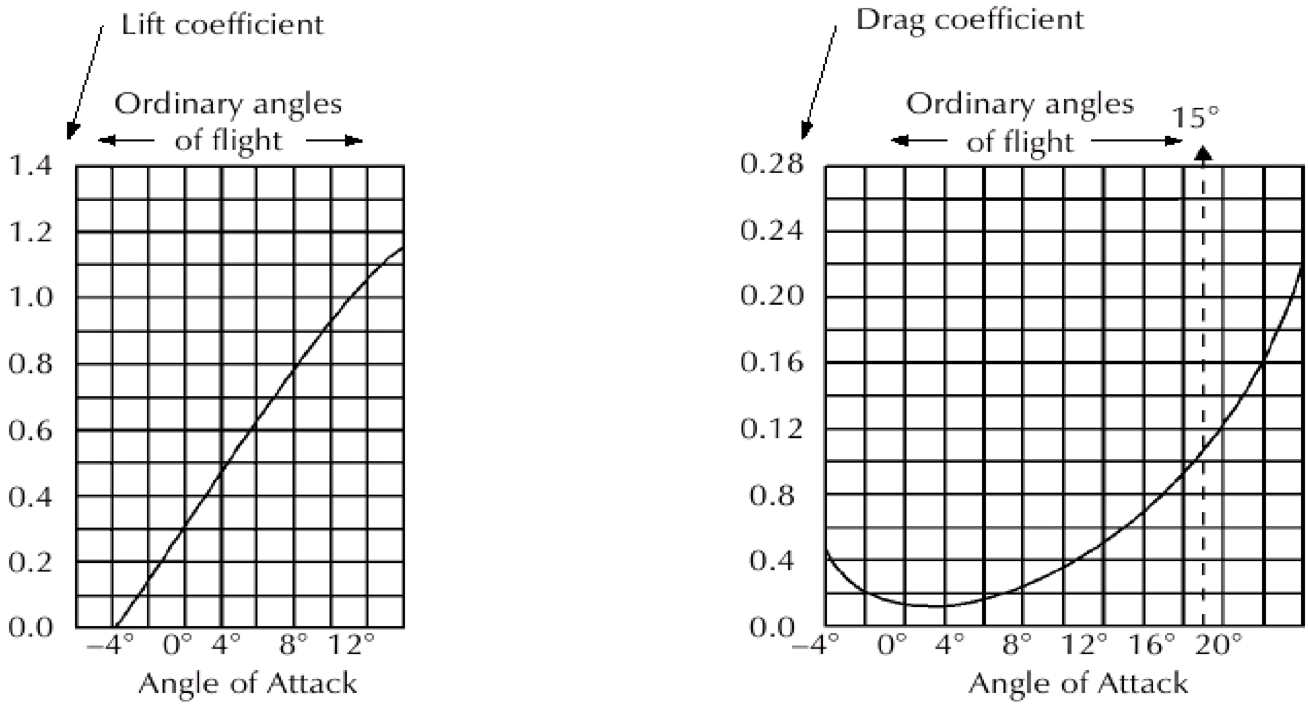

Fig. 10a Lift Curve. Fig. 10b Total Drag Curve.

With the angle of attack increased to around 15 to 16 degrees or so on most airfoils, the air can no longer flow smoothly over the upper surface of the wing because a large change of direction is needed. With the increasing angle of attack, and deceleration of the flow against the pressure gradient from low pressure above the wing back to normal pressure at the trailing edge of the wing, break up of the airflow begins at the trailing edge and moves forward. See Fig. 11.

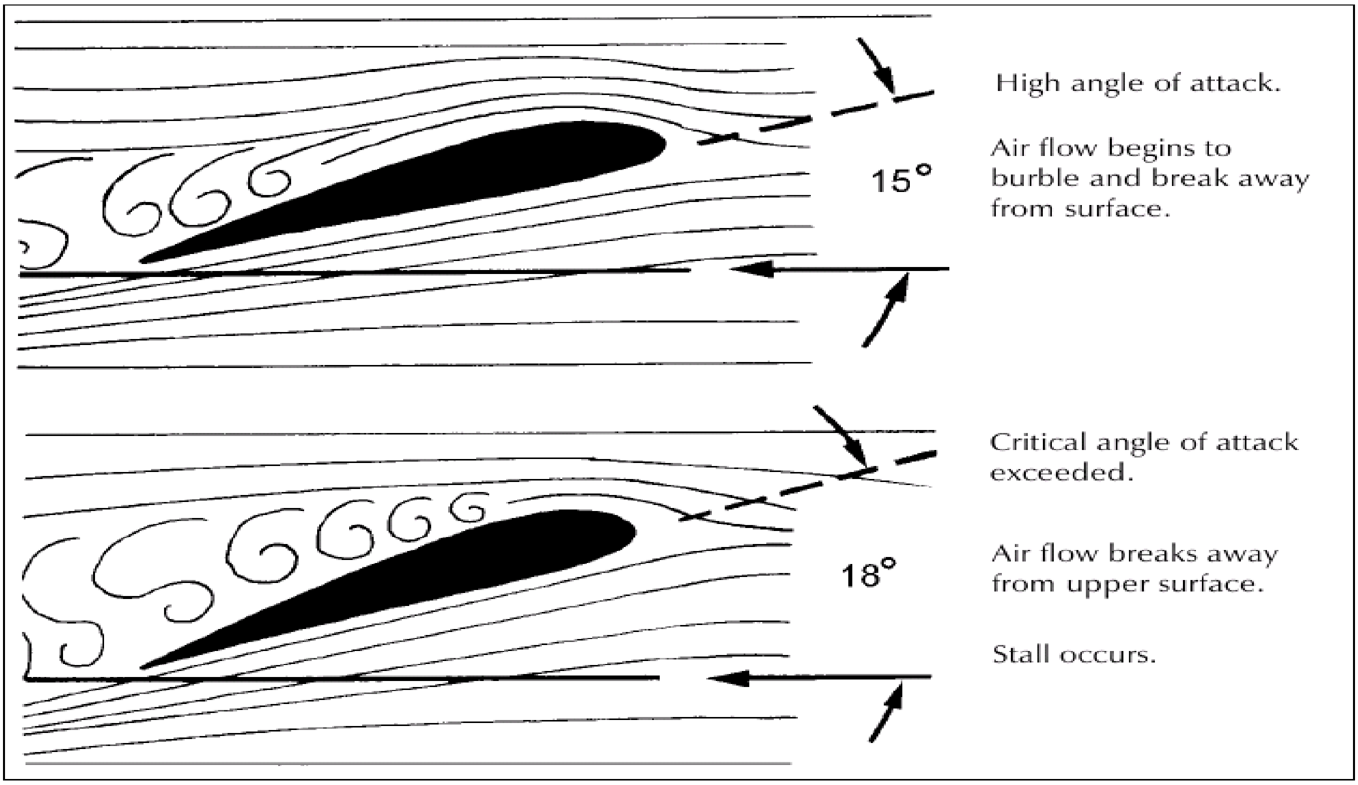

Fig. 11 Ordinary angles

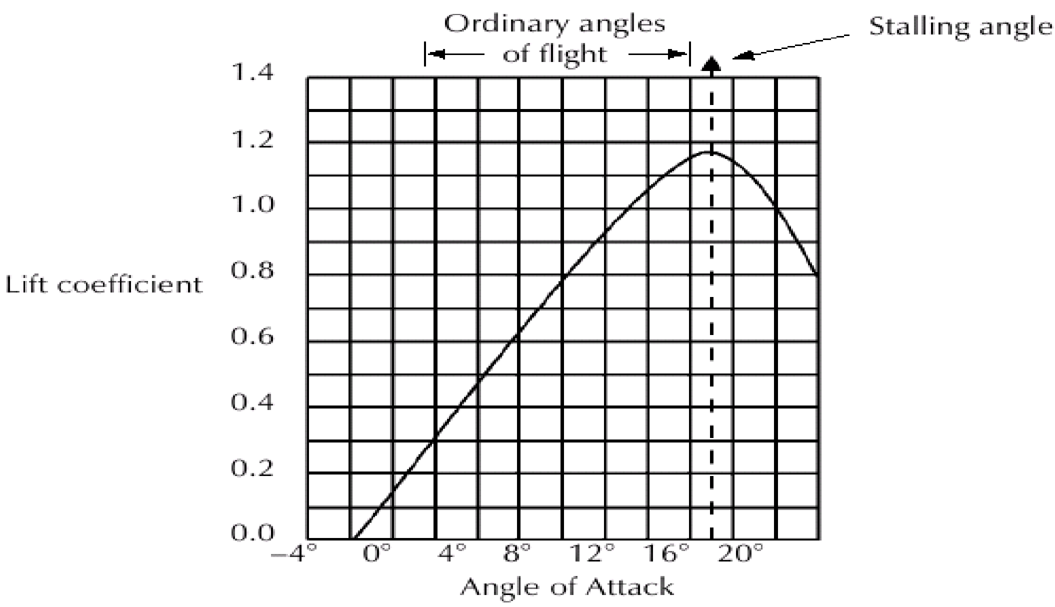

Fig. 12 Lift Curve.

At the critical angle of attack (usually around 18 degrees) the turbulent flow, which has appeared at the trailing edge at lower angles of attack, progressively spreads forward over the whole surface of the wing. This action of the airflow increases the pressure on the top surface of the wing, along with an equally sudden increase in drag. Lift is greatly reduced and the wing is said to have stalled. See Fig. 12. (Refer to Stalling section.)

Should be a diagram and narrative describing both induced and profile drag, and total drag. Slopped at which total drag is at a minimum is normally best L/D.

Centre of Pressure

If the pressure forces over the wing were combined to give a single resultant force, then the point where this resultant intersected the chord line would be called the centre of pressure. Since the distribution of the lift forces varies, then it follows that the centre of pressure moves back and forth along the chord with changes in angle of attack. For normal flight conditions the centre of pressure moves forward with increase in angle of attack and rearward with decrease in angle of attack. As the stall takes place the centre of pressure moves rapidly backwards, resulting in the nose of the aircraft pitching down because the new centre of pressure is now aft of the centre of gravity. *Need a figure to show this*

Relationship of Thrust and Drag in Straight and Level Flight

- In straight and level flight at a constant airspeed, thrust and drag are equal.
- If the thrust output of the propeller is increased, thrust will momentarily exceed drag and airspeed will begin to increase (assuming that straight and level is maintained). The increase in speed will cause an increase in drag and at some new higher speed drag and thrust will again equalise. The speed will again be constant.
- At full power, the speed will increase until drag equals thrust and the constant speed this gives will be the top speed for the aircraft in that configuration and density altitude.
- If thrust is reduced to less than the drag, the microlight will decelerate to a slower airspeed (assuming straight and level maintained) where the thrust and drag become equal. Of course, reducing the airspeed too much would result in a stall. As already mentioned, an increase in speed will increase the drag rapidly.

Relationship of Lift and Weight in Straight and Level Flight

The upward force of lift on the wing always acts perpendicular to the direction of the relative wind. In straight and level flight, lift opposes the microlight's total weight. With lift equal to weight, the aircraft will neither climb nor descend. Should lift become more than weight, the aircraft will enter a climb; and if lift become less than weight, the aircraft will enter a descent.

FACTORS AFFECTING LIFT AND DRAG

Many factors alter lift and drag, such as airfoil shape, airspeed over the wing, angle of attack, wing area and air density.

Effect of Airfoil Shape on Lift and Drag

By increasing the upper curvature of the airfoil (up to a point) the lift produced will be increased. Thus, a wing designed for high lift will have a deep wing section and possibly a concave lower surface. High lift wings, by the way, are not suited to highspeed flight because of increased profile drag.
Lowering an aileron has the effect of increasing the curvature of the wing, thus increasing the lift on that portion of the wing. Unfortunately, this also results in an increase in drag creating adverse yaw.
Raising an aileron effectively reduces the camber of that part of the wing, reducing the lift there. It also decreases drag and any adverse yaw.
Moving the tail surfaces also changes their curvature, causing the direction of their lift to change.
Any damage to the contour of the wing will have a serious effect on the lift production of that part of the wing. Stall characteristics may also change for the worse. So don't, for example, fly with sail battens damaged or missing! The shape of the airfoil is critical.

Effect of Wing Area on Lift and Drag

If wing area is doubled, other things being equal, the lift and drag created by the wing will also be doubled. Wing area cannot normally be changed by the pilot.

Effect of Airspeed on Lift and Drag

Increasing the speed of the air passing over the wing increases the lift and drag. This is because of the increased relative wind on the lower surface producing greater positive pressure, as well as the increased speed of the relative wind over the upper surface giving a lower pressure there. If we double the speed, the lift and drag quadruple (assuming the angle of attack remains the same).

Effect of Angle of Attack on Lift and Drag

As already mentioned, increasing the angle of attack increases both the lift and drag, up to a point called the "stall".

Atmospheric Effects on Lift and Drag

The density of the air affects lift and drag. As air density increases, both lift and drag increase and as air density decreases, lift and drag also decrease. The density of the air is governed by Temperature, Humidity and Pressure.

- Pressure An increase in altitude brings a decrease in pressure, which translates to less dense air. Therefore, in order to produce the same lift at altitude, the airspeed over the wings or the angle of attack must be increased. Taking off from airfields at higher altitudes requires longer takeoff distances.
- Warm air is less dense than cool air, therefore performance suffers in warmer air.
- Moist air is less dense than dry air, therefore performance will suffer in moist air.

From above it is clear that on hot, humid days, operating from high altitude fields will see the microlight's performance at its worst

EFFECT OF CONTROLS

Conventional aircraft are considered to have three axes of movement. Whenever the aircraft changes attitude in flight, it will rotate around one or more of these axis. The three axis intersect at the centre of gravity and each one is at right angles to the other two. See Fig. 13.

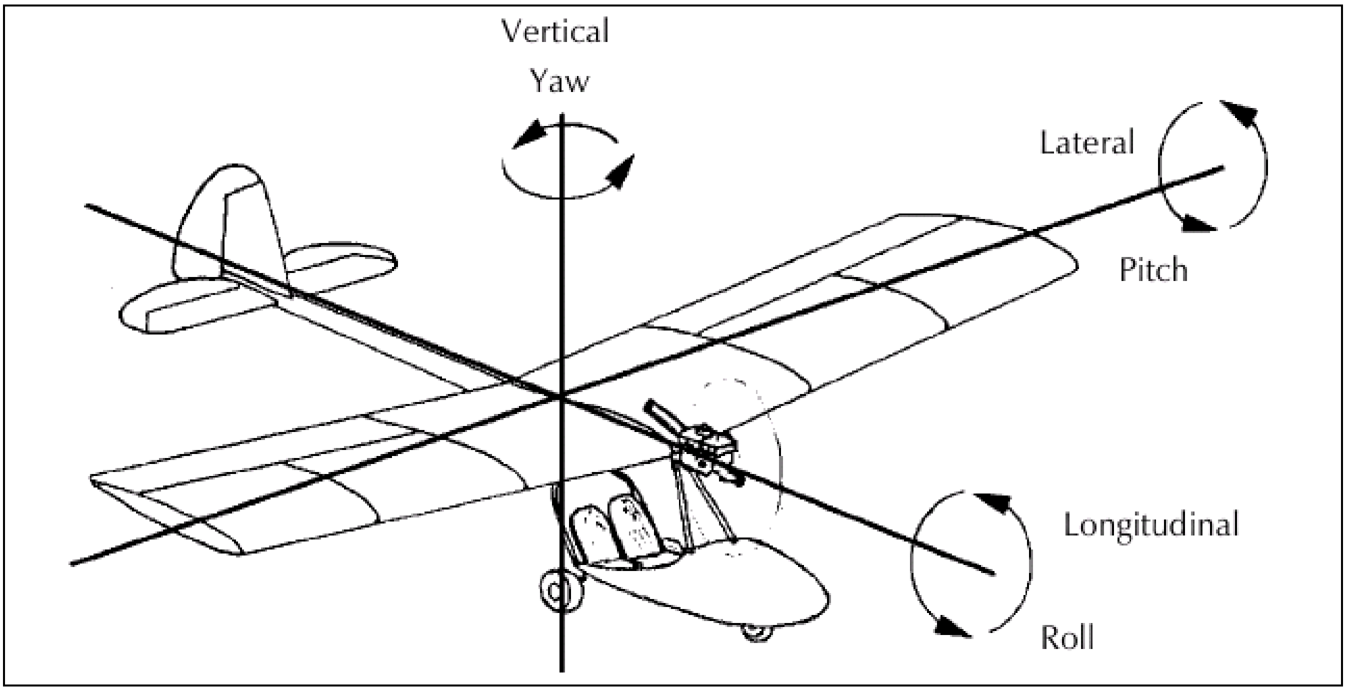

Fig. 13

Three Axis of Motion.

- The Lateral or Pitch Axis: This is a straight line through the centre of gravity and running spanwise toward the wingtips, at right angles to the longitudinal and vertical axes. Movement around this axis is called pitching and is achieved with the elevators.
- The Longitudinal Axis: This is a straight line running lengthways through the aircraft's centre of gravity from nose to tail. Movement around this axis is called rolling and is achieved with the ailerons.
- The Vertical or Normal Axis: This is a straight line through the centre of gravity and is vertical when the aircraft is in the rigging position, it is at right angles to the longitudinal axis. Movement around this axis is called yawing and is achieved with the rudder.

Control Surfaces

For the purposes of this section we will be dealing with a microlight of conventional layout and control configuration. In a later section we will look at some other configurations.

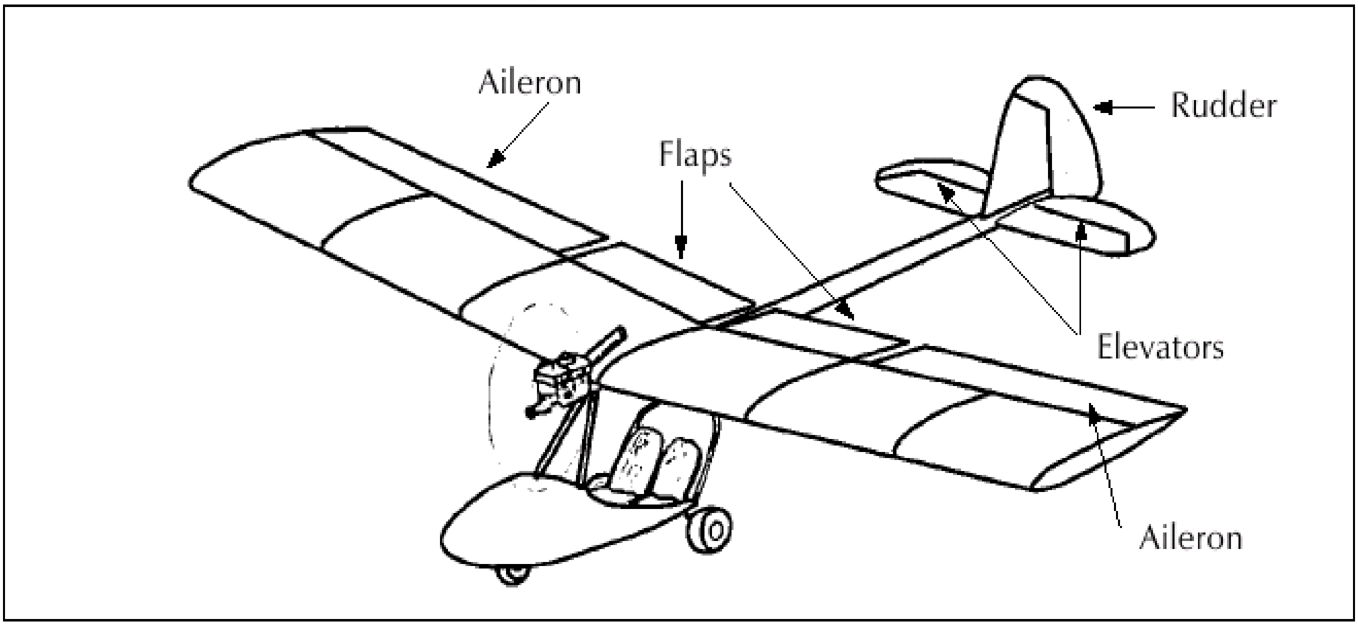

Fig. 14

Controls on a conventional three axis microlight.

- Elevators: The elevators control movement about the lateral axis, which is called pitch. The elevators are hinged to allow the surface to move up and down. On some aircraft, the entire horizontal tail surface may move, but usual y it is only the aft portion that moves. The horizontal tail surface along with the elevators make up a single airfoil. Changing the position of the elevators therefore alters the camber of the horizontal tail surface and thus increases or decreases the lift it produces. The elevators are connected to the control stick and fore and aft movement of the stick moves the elevator surface. Moving the stick forward moves the elevator down, while aft stick moves the elevator up. Forward stick therefore increases the lift of the tail surface and causes the nose to pitch down. The elevators control the angle of attack of the wings. When the nose is lowered, the angle of attack is reduced. When the nose is raised, the angle of attack is increased. See Fig. 15.

The elevators primarily control the airspeed.

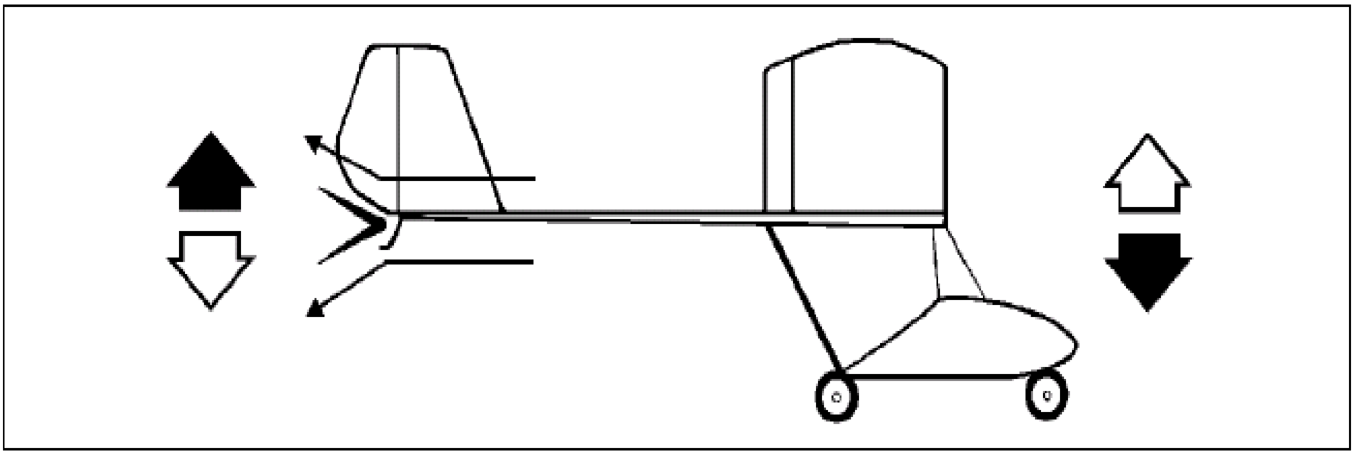

Fig. 15 Effect of Elevator.

- Ailerons: The two ailerons, located at the trailing edge of the wing, are moveable surfaces that control movement about the longitudinal axis. On some types these surfaces span the entire trailing edge of both wings. As one aileron surface is lowered, the other is coupled so that it is raised. The wing with the raised aileron goes down because of decreased lift. Moving the control stick to the right moves the left aileron down and the right aileron up, rolling the microlight to the right. This happens because the down going left aileron increases the wing curvature (camber) and thus increases the angle of attack. The right aileron moves upward and decreases the camber, resulting in a reduced angle of attack. Thus the decreased lift on the right wing and the increased lift on the left wing causes a roll and bank to the right. See Fig. 16.

The ailerons control angle of bank.

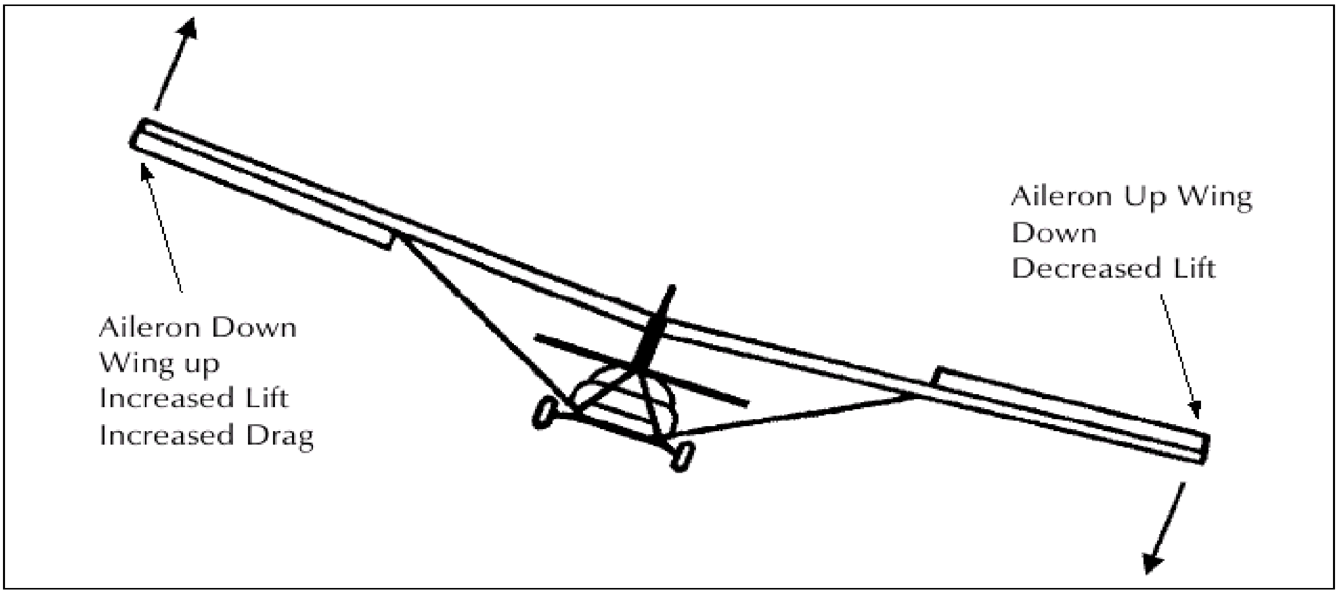

Fig. 16 Effect of right control stick (rear view).

- Rudder The rudder surface controls movement of the microlight about its vertical or normal axis, which is called yaw. Much like the elevator, the rudder is a hinged surface which may swing from left to right and is attached to what is called the vertical stabiliser or fin. Its action is similar to the elevator except that it produces movement in yaw axis, swinging the nose from side to side. It is controlled by the rudder pedals. Application of the left pedal starts a yaw to the left and the right pedal to the right. See Fig. 17. The rudder is normally not used to initiate turning of the microlight, but rather to balance the turn, as we shall see shortly.

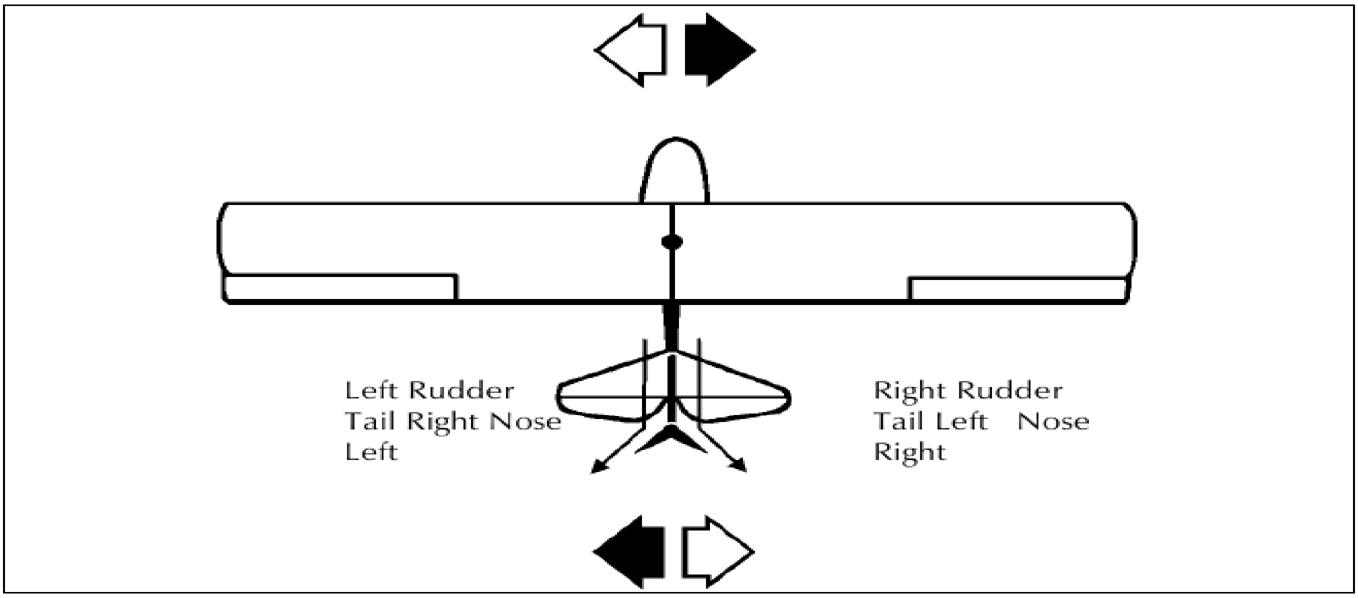

Fig. 17 Effect of Rudder.

- Flaps: Flaps are another aerodynamic control surface found on an increasing number of microlights. Flaps work in the same way as ailerons and vary the wing camber, they provide a decrease in landing speed when deployed whilst retaining maximum speed when up. The flaps on each wing are connected so that they can be raised and lowered together (as opposed to ailerons where one goes up while the other goes down). By increasing the effective lift, flaps reduce the stalling speed and enable the microlight to fly at lower airspeeds. Also, by increasing drag flaps enable the aircraft to glide at a steeper angle with no increase in forward speed. See Fig. 18. Microlights utilise flaps either inboard of the ailerons or in combination with the ailerons called Flaperons. Flap use sometimes causes a pitching moment by shifting the wing's centre of pressure. Flaps are normally partially down to shorten the Take-Off roll, and fully down to shorten the approach and landing. There is a maximum speed limit for flap lowering to avoid overstressing the mechanism, refer to your aircraft's handling notes for optimum settings and recommended speeds.

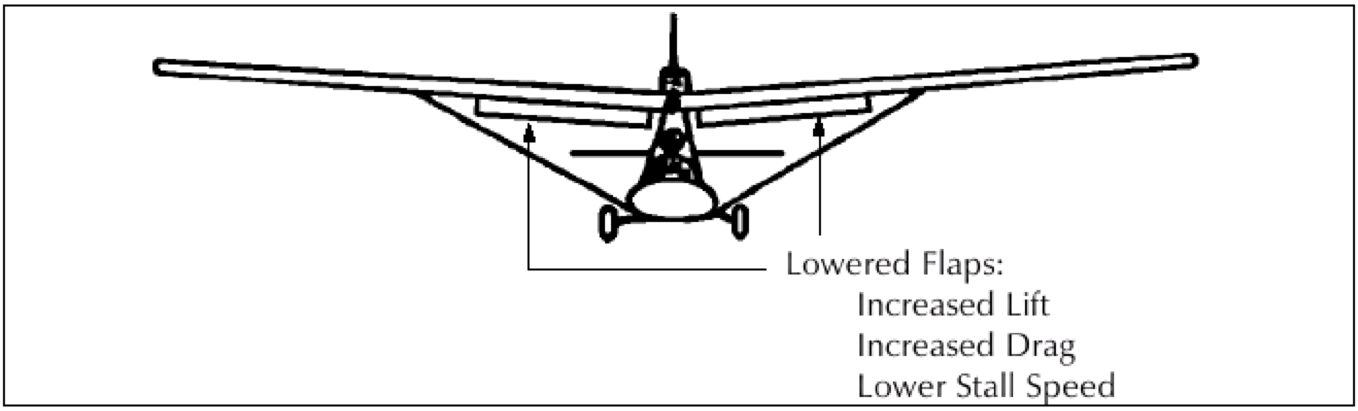

Fig. 18 Effect of Flaps.

- Trim devices: Some microlights have the means to reduce the manual loads in the controls in some modes of flight. For example, an elevator trim can be used to ease the backpressure required to maintain a climb, or could be altered to provide hands-off level flight. On some aircraft this may be achieved by physically moving the entire control surface to get the desired effect. Sometimes a spring tension is applied to the surface or control linkages/cables. Another is the trim tab which is a small moveable surface attached to the control surface. Moving this tab surface alters the lift characteristics of the control surface it is on, thus changing the stick loads felt by the pilot. Trim is used each time the aircraft attitude is changed, to provide hands-off flight in each new attitude.
- Throttle: The throttle controls power output from the engine. Full power is required for take-off and maximum climb, reduced power for cruise, and considerably less for descent.

The throttle controls rate of climb and descent.

Further Effects of controls

In addition to the primary effects of controls already mentioned, each control application will produce a secondary effect which must be considered.

- Aileron: Use of ailerons will produce yaw. This is due to the uneven drag of the up and down ailerons and is called adverse yaw or aileron drag.
- Elevators: Use of the elevators alters the angle of attack of the wing, and this effects the speed of the microlight.
- Rudder: Use of the rudder produces yaw. This yaw increases the speed of the wing opposite the direction of the yaw which produces greater lift on that wing thus inducing roll in the same direction as the yaw.
- Throttle: Increased power normally causes a "pitch up" moment with yaw, while decreased power causes a "pitch down" moment with yaw. The greater the power variation, the greater the effect. Increased throttle also produces torque which must be balanced by rudder. The pitch response to throttle is also dependent on the thrust line- in a microlight with a high thrust line, applying full power may cause a noticeable pitch down response.

Effect of Airspeed:

- High airspeed all controls firm and more effective.
- Low airspeed all controls sloppy and les effective.

Effect of propellor slipstream:

- High power rudder and elevator firm and more effective.
- Low power rudder and elevator sloppy and less effective.

Ailerons are outside of the propeller slipstream and give a good indication of airspeed.

STRAIGHT AND LEVEL FLIGHT

We have already seen that in straight and level flight, the four forces acting on the microlight are balanced with their opposite, (assuming a constant airspeed). Level flight is possible at any speed above the stall speed, right up to the maximum attainable in level flight. Let us look at a microlight in level flight at full power. The four forces are balanced, with thrust equalling drag, and lift equalling weight. If we were to reduce power to, say 75%, what happens? As the thrust is reduced, drag slows the aircraft down until thrust equals drag again.

If we had kept the angle of attack the same, the aircraft would now begin to descend because at the same angle of attack the lower speed will produce less lift. So, in order to maintain level flight at this lower speed, we have to increase the angle of attack to produce the lift needed.

This process continues as we slow down further. The slower the airspeed, the greater the angle of attack needed to produce the lift needed for level flight. However by increasing the angle of attack remember we are also increasing the drag created by the wing. Excessively high angles of attack with low airspeed can result in a stall and spin.

We can counter this by applying more power, but if the aircraft is in slow flight with a nose high attitude then there comes a point where there will be insufficient extra power available. This situation is called "flying on the backside of the power curve" or "Deadmans Curve!" and occurs when the power available is insufficient to overcome the drag when flying at a high angle of attack.

The situation is most likely to develop if the pilot throttles back while climbing and then at a slower airspeed, and in a nose high attitude, opens the throttle again and the aircraft does not respond as expected. The recovery is simply to lower the nose allowing the airspeed to return to a higher figure. The danger of the above situation is much greater if near the ground as there may be insufficient height for recovery. Recovery will mean a loss of height.

A similar situation could develop if the pilot attempts to initiate a climb immediately after take-off and before the aircraft has accelerated to an airspeed that will allow it to climb safely. The recovery is to lower the nose, reducing the angle of attack, and waiting for the airspeed to return to a higher figure.

The purpose of this section is to point out that a high power setting does not necessarily mean flight at high speed. It is the elevators and thus angle of attack which is primarily responsible for speed control. Remember, flight is possible at low speed and high angle of attack, high speed and low angle of attack, and an infinite number of combinations of angle of attack to obtain the same value of lift.

CLIMBING

We have already seen that a climb will result if lift exceeds weight. As long as there is more thrust available than that required for level flight, then the microlight can be made to climb. The more excess thrust available the greater the rate of climb possible. When we raise the nose increasing the angle of attack to produce the extra lift to initiate the climb, we know of course that the airspeed will drop and then reduce lift as we do so. For this reason, the extra power needed to sustain the climb should be applied just before raising the nose. See Figure 19. When returning to level flight from a climb it is necessary to lower the nose and build up airspeed before reducing power. See Figure 20.

When making changes in altitude or reestablishing level flight from a climb, use the following:

When entering a climb from level flight

1. **P**ower. Apply climb power.
2. **A**ttitude. Change the attitude to the climb position.
3. **T**rim. Trim if applicable.

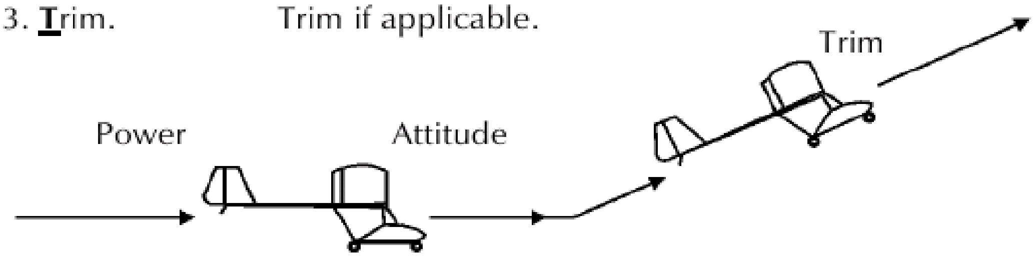

Fig. 19

When entering level flight from a climb

1. **A**ttitude. Lower the nose to the level flight attitude allowing speed to increase to cruise speed.
2. **P**ower. Reduce power to cruise power.
3. **T**rim. Trim if applicable.

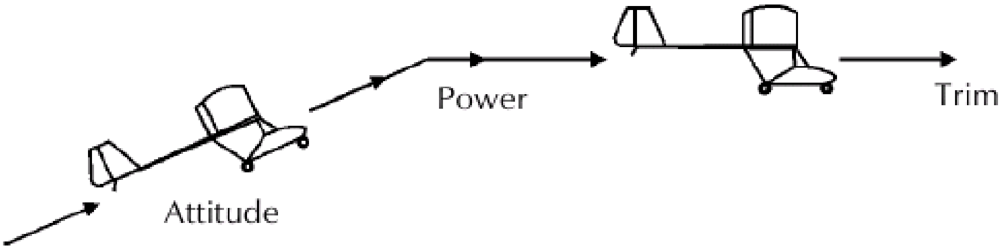

Fig. 20

- Best Rate of Climb (altitude gained in a given time)

At climb power, every aircraft has a climb airspeed which will give an optimum rate of climb. This airspeed corresponds to an angle of attack which provides the most lift for the least drag (best L/D). In this configuration the aircraft will climb the highest in the least time. If a rapid climb is desired, to climb at above the optimum speed will reduce the rate of climb, since there is thrust being wasted on airspeed rather than lift production. Likewise, attempting to climb at below the optimum speed will reduce the rate of climb as the extra drag of the higher angle of attack requires more thrust (which is not available) to counter it. See Figure 21. *This airspeed is normally also the best glide airspeed.*

- Best Angle of Climb (altitude gained in a given distance)

The best (steepest) angle of climb will be achieved with climb power at an airspeed a little less than that for the best rate of climb. This airspeed corresponds to an angle of attack which produces the most lift but higher drag. Here again, maintaining the right airspeed is important if the best angle of climb is desired. *This airspeed is normally also the minimum sink rate airspeed.*

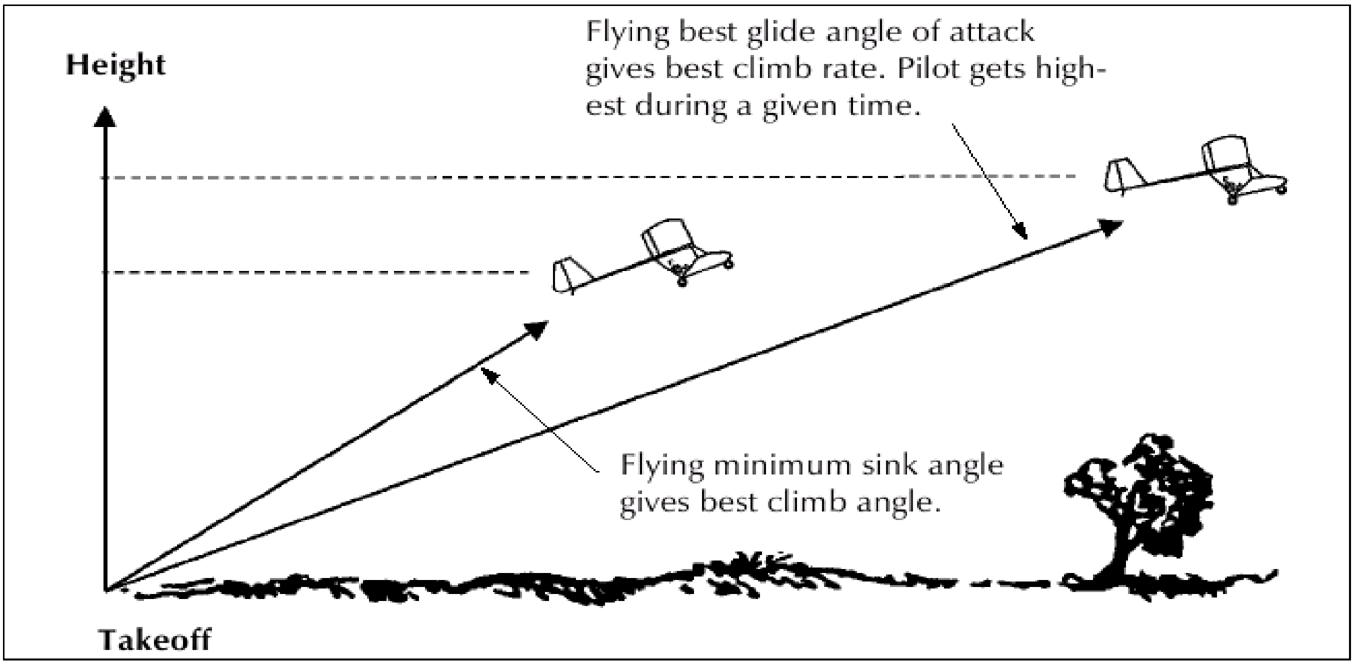

Fig. 21 Best angle of climb versus best rate of climb.

- Factors Affecting Climb Performance

An increase in weight will reduce rate and angle of climb. Rate and angle of climb will reduce with increasing altitude as engine, propeller and airfoil performance suffers from reduced air density. Climb performance will be reduced in warm and humid air.

The use of flaps can allow for an increase in the angle of climb and a reduction in the climb airspeed.

Best angle of climb would only be used after takeoff from a short field where obstacle clearance is important and once clear, best rate of climb airspeed would be resumed.

Check your owner's manual for any best climb speed given. The usefulness of such information is dependent on the accuracy of your air speed indicator as a few knots variation either way could greatly detract from the desired performance. Care should be taken in some aircraft to avoid overheating the engine in a climb. If necessary, level off occasionally or increase airspeed to aid cooling.

It must be stressed that the correct airspeeds be maintained in order to climb efficiently. Holding the nose as high as possible with full power does not mean the microlight is climbing well ! Indeed it may be descending! Maintain a healthy margin above the stall speed during the initial climb, until well clear of the ground.

DESCENDING

A microlight will descend from level flight any time there is insufficient thrust to maintain level flight and/or the weight of the aircraft is more than the lift being produced.

From level flight we can descend either by lowering the nose, reducing power, or both. It can be seen that descent is possible at any power setting and this is because gravity is the force naturally trying to make the aircraft descend at all times.

From level flight at cruise speed, for example, if we lower the nose the angle of attack is reduced and the reduced lift initiates the descent. If we have not reduced the power, the speed will increase considerably as we now have both thrust and gravity assisting us in our downward path.

When the forces of thrust and gravity equalise with the drag of our new speed, the rate of descent will stabilise.

Descents are usually made with reduced power because in this way there is less increase in speed. During a descent with power on, the aircraft may reach its maximum permissible speed fairly easily and at a shallower angle than with power off. When entering a descent from level flight, first reduce power, maintain height until airspeed reaches descent speed, then lower the nose for the descent and trim (if applicable). Periodical y warm the engine during long descents at low power to avoid overcooling and/or spark plug fouling.

The use of flaps can allow for an increase in the angle of descent and a reduction in the approach airspeed.
When making changes in altitude or reestablishing level flight from a descent, use the procedures shown in Figues 22 and 23.

When entering a descent from level flight

1. **P**ower.	Reduce power.
2. **A**ttitude.	Lower the nose to the descent attitude.
3. **T**rim.	Trim if applicable.

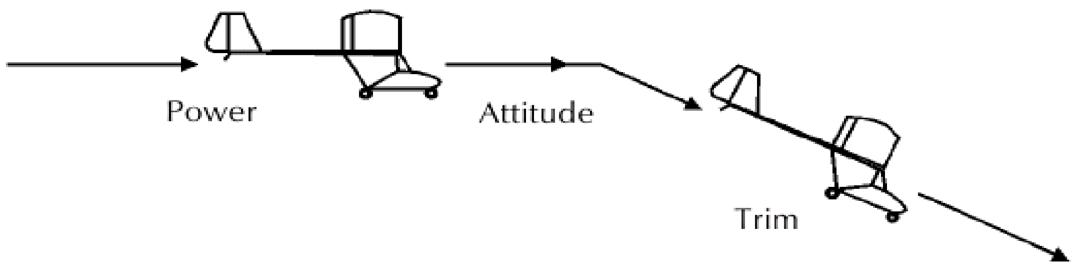

Fig. 22

When entering level flight from descent

1. **P**ower.	Increase to cruise power.
2. **A**ttitude.	Raise the nose to level flight attitude.
3. **T**rim.	Trim if applicable.

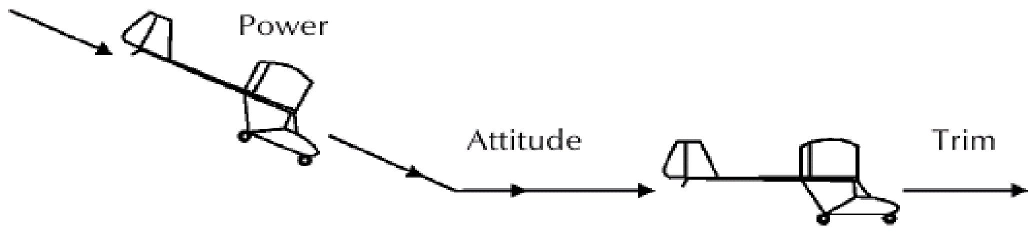

Fig. 23

GLIDING (Figure 24)

If we look at our four forces of flight we see that with the power off, gravity takes over the job of thrust in providing our forward momentum and the flight path is downward.

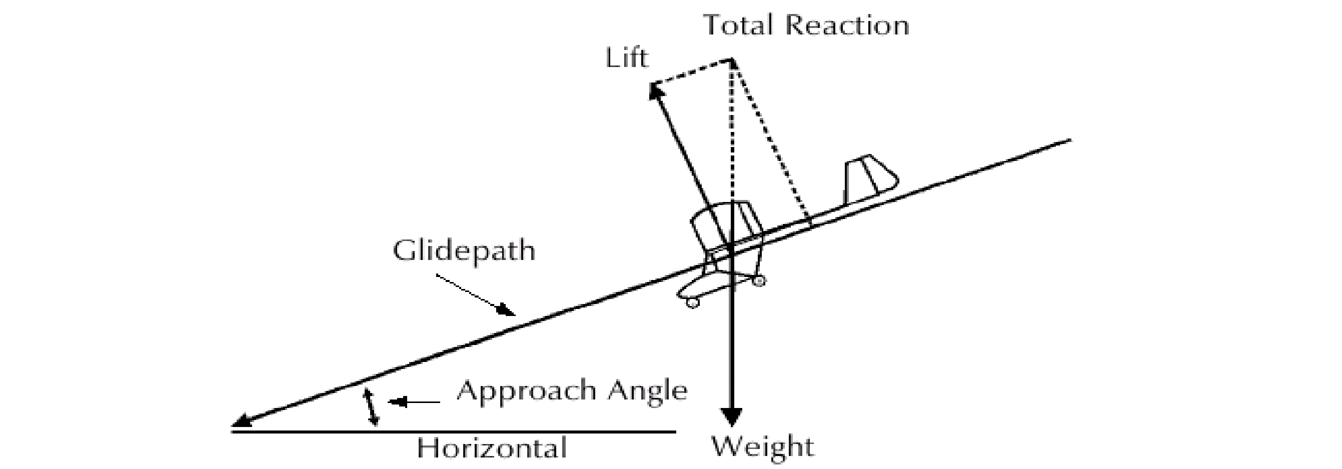

Fig. 24

The pilot still has complete control with the exception of being able to climb or maintain height.
At a given airspeed, the most lift for the least drag will be produced by the wing and at this speed the microlight wil glide the greatest forward distance for the least height lost (best L/D speed).
At another slightly slower speed, more lift will be produced, but at the cost of more drag, resulting in the least rate of descent possible with power off. This speed gives the best duration in the air but NOT distance. See Figure 25.

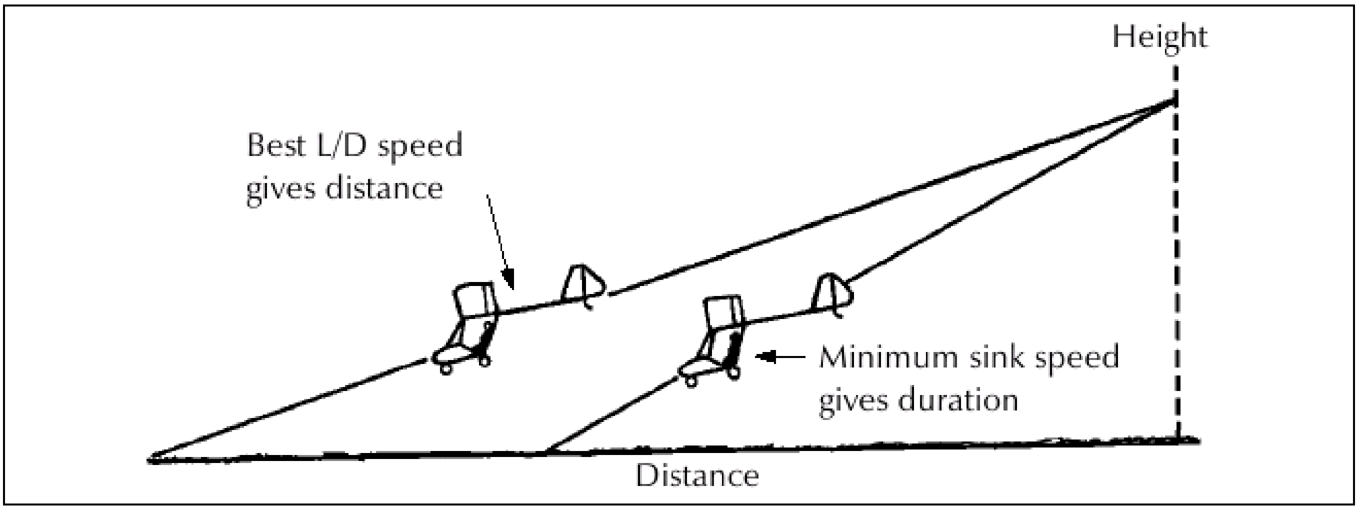

Fig. 25

The correct use of flaps will reduce the best L/D speed and sink rate.
Consult your owner's manual for the best L/D and best sink rate speeds.
Care must be taken to maintain sufficient airspeed in the glide, especially near the ground as stall recovery without power requires considerably more altitude.

TURNING

Two fundamental laws of mechanics must be borne in mind when considering medium turns.
Firstly, a microlight will continue in a straight line at a constant velocity unless acted upon by an external force.
Secondly, the acceleration applied by an external force is inversely proportional to the mass. In other words, the heavier the microlight the larger the force required to change direction and the more resistance to that change in direction (i.e. inertia).
At this point it is appropriate to mention that a pilot must not enter a turn unless a proper lookout has been done.
"Proper lookout means that the pilot has checked to the right, centre, left, above and below, before changing direction or altitude."
When flying a high wing microlight, it makes good sense to "clear the turn" first. This is simply done by first momentarily raising the wing on the inside of the intended turn and checking for traffic in that direction. If it's clear, proceed with the turn. Low wing microlights don't need to "clear the turn", since the inside wing clears the view as it drops, but you must always check before initiating the turn.
A turn is produced by lift pulling the microlight from its straight course while overcoming gravity.
Thus, if altitude is to be maintained in a turn the wings must produce lift equal to the weight of the microlight plus the centrifugal force caused by the turn. See Figure 26.

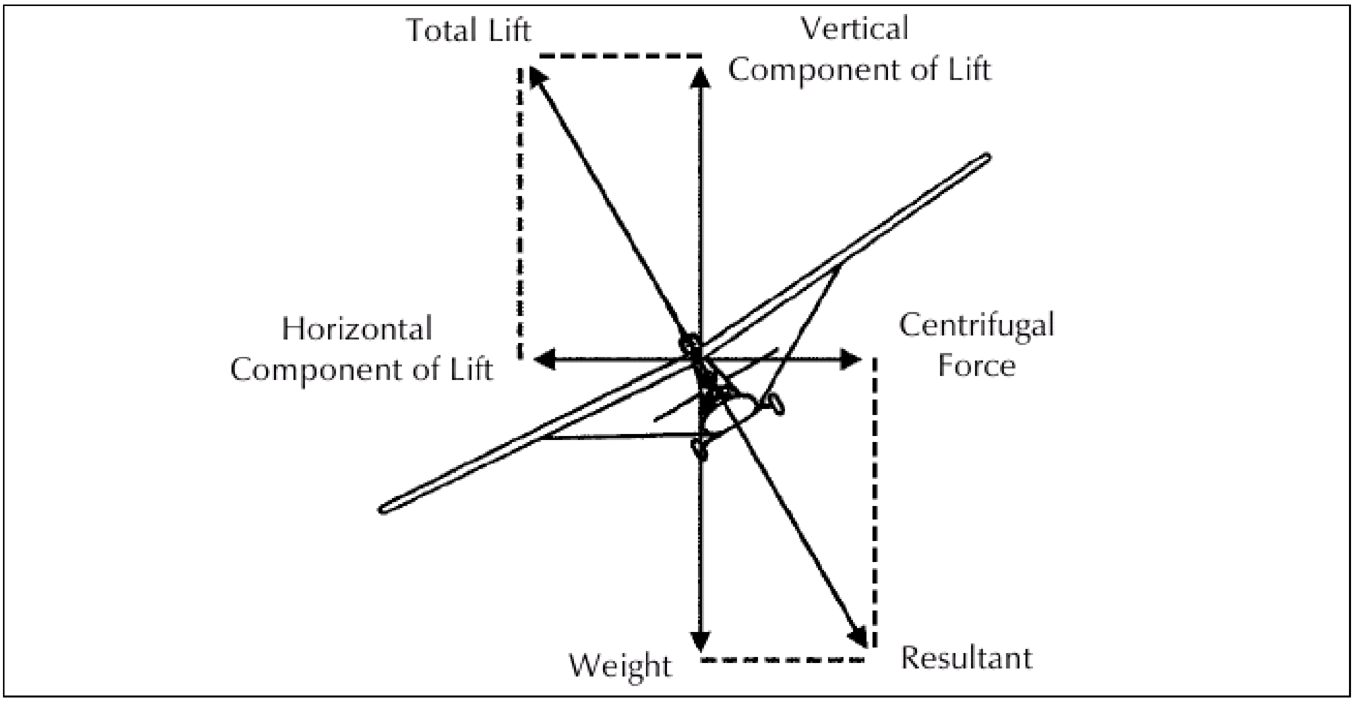

Fig. 26

The increase in lift is normally obtained by increasing the angle of attack, the airspeed or the power (or all three). So it is inclining the lift that produces the turn. If a turn is made during a climb, the rate of climb will decrease as some of the available lift is being used to effect the turn, rather than help the climb. Therefore, whilst climbing, only shallow angles of bank should be used so that a positive rate of climb can be sustained.

To initiate a medium turn from level flight the aircraft must be rolled in the desired direction with the ailerons. It is here that adverse yaw may appear.

Adverse or Aileron Yaw as it is often called, is a yaw produced by the ailerons. Remember in the effect of controls section, it was stated that the down going aileron increases the curvature (camber) and thus the lift. Unfortunately, a further effect of this is increased drag. Therefore, the wing with the lowered aileron (which produces more drag than the raised one), causes a yaw to that side, which is the opposite side to the direction of the desired turn.

For this reason, it is important to prevent this yaw and maintain balance with the rudder in the direction of the turn (with reference to the slip indicator, or yaw string), i.e. no slipping or skidding. See Fig. 27.

So, here we are with the microlight rolled to about 30° angle of bank and the slip indicator indicating balanced flight. As we rolled, the nose wil have wanted to drop a little and this is prevented with aft stick which increased the lift (angle of attack). Now the microlight will be turning.

- The **speed** is controlled with the **elevator**
- The **angle of bank** with the **ailerons**
- The **balance** with the **rudder**
- The **rate of climb or descent** is controlled with **throttle**.

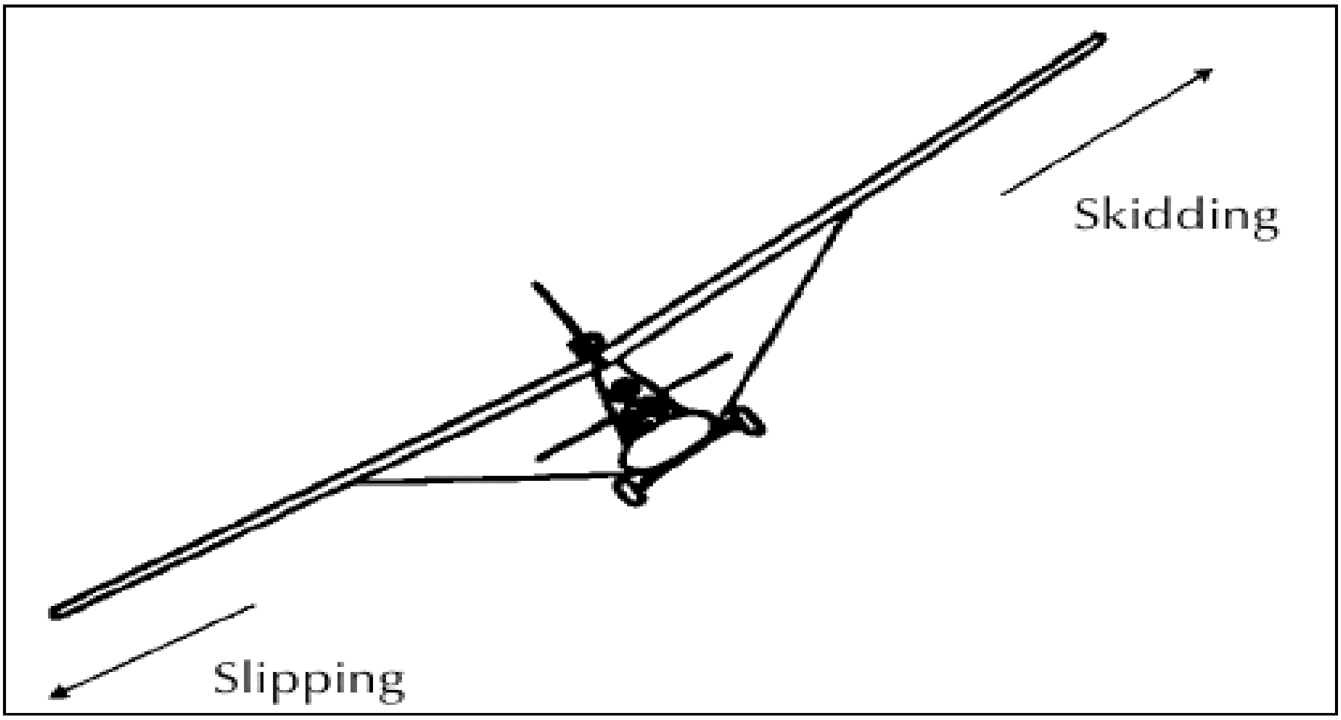

Fig. 27

To stop the turn, roll the aircraft level with the ailerons while maintaining balance with the rudder and keeping the nose from rising or falling with the elevator. In the turn the outside wing travels through the air faster than the inside wing so it will develop more lift and tend to roll the microlight into the turn even more. This has to be countered with opposite aileron once in the turn.

LOAD FACTOR

- Effect of Turn on Load Factor

Since a turn is produced by inclined lift pulling the microlight from its straight course while overcoming gravity, if altitude is to be maintained the wings must produce lift equal to the weight of the microlight plus the centrifugal force caused by the turn.

As the bank gets steeper the centrifugal force builds up. Therefore, any time the microlight flies in a curved path at a constant altitude, the load supported by the wings is greater than the weight of the microlight, thus the load factor increases. See Fig. 28.

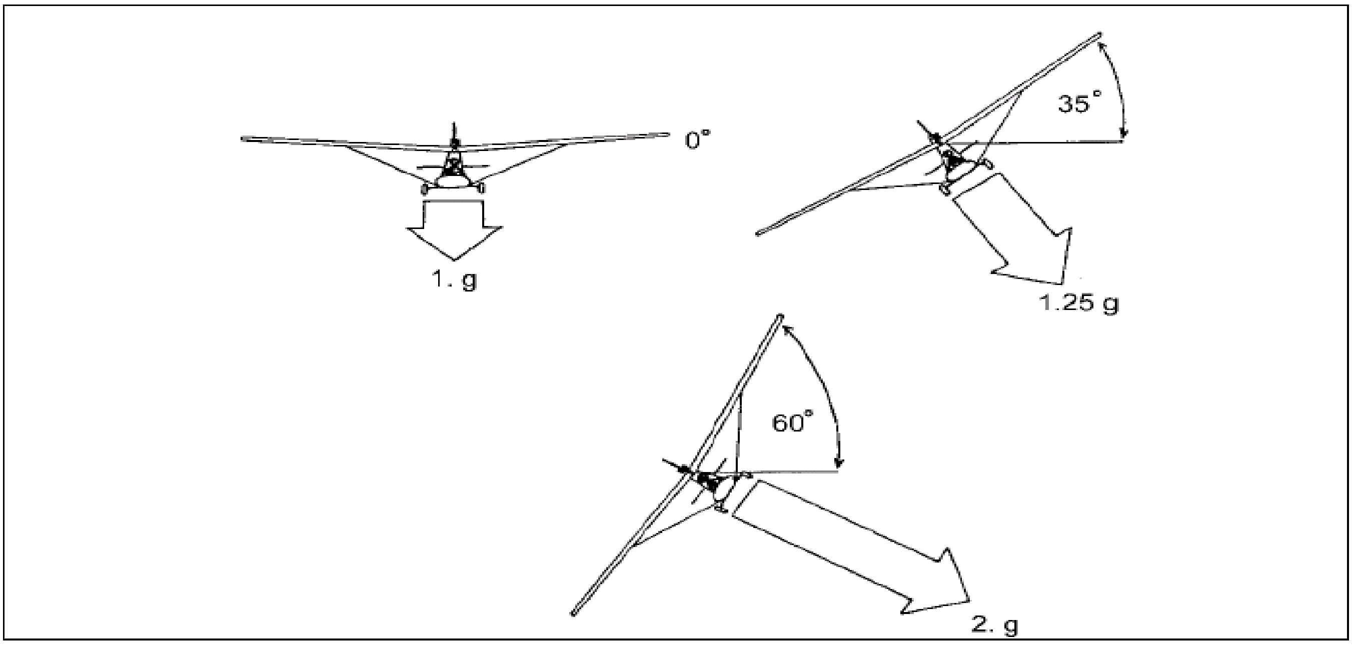

Fig. 28

- Effect of Load Factor on Stall Speed

With an increase in load factor there is an increase in stall speed. The load factor increases when a microlight follows a curved flight path (turns), pullouts from dives, or sudden application of backpressure on the control stick. Consequently, the stalling speed also increases in these same manoeuvres.

- Effect of Turbulence on Load Factor

Severe vertical gusts impose loads on the wings which can be excessive. These gusts cause a sudden change in angle of attack, resulting in large wing loads which are resisted by the microlights inertia.
When encountering strong turbulence, reduce airspeed. This enables the airframe to withstand the forces more easily.

Assuming a constant airspeed, the load factors at various angles of bank will be:

Angle of Bank	**Load Factor**
0	1g
35	1.25g
50	1.5g
60	2g
75	4g
83	9g

The increase in load factor causes an increase in stalling speed:

Angle of Bank	**Stalling Speed Increases by**
60	40%
75	100%
83	200%

As the loading is increased, the stalling speed increases and the microlight becomes less manoeuvrable. The pilot will feel the force pushing him/her down into the seat.
At high loadings, the pilot's vision may be impaired and at about 5g or 6g the pilot may "black out".
During recovery from steep dives, al ow for the extra height loss due to inertia and also the higher staling speed.

STEEP TURNS

The principles of flight relating to steep turns are the same as those for medium turns. With a steeper angle of bank, the rate of turn is greater. With medium turns it was mentioned that extra lift had to be produced to maintain height and it is the same for steep turns, although considerably more lift is needed. To achieve this, as the bank is applied, the power is increased to help counter the increased drag of the high angle of attack. Altitude can be easily gained or lost, and should be controlled with the aileron by varying the angle of bank.
Available power is usually the limiting factor in steep turns and few microlights can sustain angles of bank greater than 50 60 degrees without losing height.
Just as in any other turn, airspeed is still controlled with the elevator, angle of bank with the ailerons and balance with the rudder.
The increased lift required during turns increases the load factor and, as previously discussed, this increases the stall speed:

Angle of Bank	**Loading**	**Increase in Stall Speed**
30	1.16 times	10%
60	2 times	40%
75	4 times	100%

The increase in loading stresses the microlight airframe and there is a design limit each type can safely handle. Find out the extent of your aircraft's ability to withstand this g loading from the owner's manual.

The pilot, of course, is also subjected to this loading in turns and it is felt as a pressure pushing one into the seat. The amount of this g force the body can handle varies from person to person, but most people feel decidedly uncomfortable at 3g.

It should be pointed out that for brief periods one can cope with quite high loadings on the body and it is extremely difficult to judge this accurately. Therefore, a careless pilot could easily overstress his microlight momentarily with improper use of the controls, and not realize it.

The increase in stall speed dictates a higher entry airspeed into the steep turn. Failure to maintain sufficient airspeed in the turn could result in a stall. To stall in a steep turn invariably results in a rapid change in direction and loss of height (and may possibly develop into a spin).

More height may be needed to recover from such a stall and steep turns **must** be avoided near the ground, particularly the turn onto final approach.

To summarise, an increase in rate of turn requires:

- **Before entering any turn LOOKOUT !!!**
- Increased angle of bank.
- Increased angle of attack.
- Increased power.

which results in:

- Increased wing loading.
- Increased stall speed.
- Decrease in air speed (due to extra drag of high angle of attack).
- Effect of speed on Load Factor

The degree of excess load the microlight is exposed to depends on how fast it is flying.

At slow airspeed, the available lifting force of the wing is only a little greater than what is needed to support the weight of the microlight. As a result, the load factor cannot become excessive, even if the controls are moved abruptly.

At high airspeed, the lifting force of the wing is so high that a sudden gust or sharp movement of the controls could increase the load factor beyond safe limits.

"At high airspeed avoid rough air and abrupt, coarse control movements."

SPIRAL DIVE

As mentioned in the section on turning, the nose must be raised to provide the extra lift needed to maintain level flight in the turn. However, if the correct nose attitude is not held, and the nose is allowed to drop, the microlight will begin to descend (and rate of turn will be less).

A descending turn like this can develop into a spiral dive.

There is nothing wrong with a spiral dive as long as the airspeed is kept within limits, the loading is not excessive and the correct method is used to recover from it.

Unfortunately, the spiral dive can be a problem for new pilots as they make turns. If they allow the nose to drop too much in the turn, there comes a point where trying to raise the nose with elevator merely tightens the descending turn. This is not a big problem at shallow angles of bank, but if ever in a descending turn, the development of a spiral dive is possible.

Symptoms of a Spiral Dive

- Nose below the horizon.
- Airspeed increasing.
- Moderate to steep angle of bank and turning.

Confirmation that you are in a spiral dive will occur if you try to raise the nose to recover from the dive. There will be a tightening of the turn and increased G loading felt without any recovery from the dive. Your instructor will demonstrate this condition and the correct recovery which is:

"Roll the wings level with the ailerons, reduce power, and ease out of the dive."

By rolling level first, the turn is eliminated leaving the microlight in a dive, which is recovered by raising the nose (being careful not to do so too abruptly, thus overstressing the airframe). Pitching up too quickly can also cause a high speed or 'shock' stall.

STALLING

We have already seen that by forcing the angle of attack of the wing too high the smooth airflow over the top surface of the wing is destroyed and lift is lost. In this condition the wing is said to have stalled.
Symptoms of the Stall

- Low airspeed (generally, unless the angle of attack is forced too high at a high airspeed).
- High angle of attack (note this is wing angle of attack and not the machines attitude).
- Sluggish controls.
- Buffeting caused by turbulence over the wing and the tail surfaces.
- Nose and sometimes wing drop. (Some microlights have an indistinctive and mushy stall without appreciable nose or wing drop.)

Typical stall from Level Flight

With the increase of angle of attack, the airspeed will reduce, providing the first clue to the pilot through both the airspeed indicator and the sound and feel of the airstream diminishing.
As the airspeed reduces further the controls become sluggish. Normal movements of the controls provide only poor response. Depending on the aircraft, it may feel nose heavy, requiring effort to hold the nose up.
With the angle of attack getting very near to stalling point, the smooth airflow over the top of the wing may begin to break up from the trailing edge, causing a turbulent flow over the tail surfaces which may be felt as buffeting in the airframe and controls. On some aircraft it is possible to see the wing covering wrinkle as the flow becomes turbulent. The microlight is now very near the full stall and any further increase in angle of attack will stall the wing. The instantly this occurs, the controls will seem to have little or no effect, as airspeed is very low. The nose will want to drop and a wing may drop also. See Fig. 29.

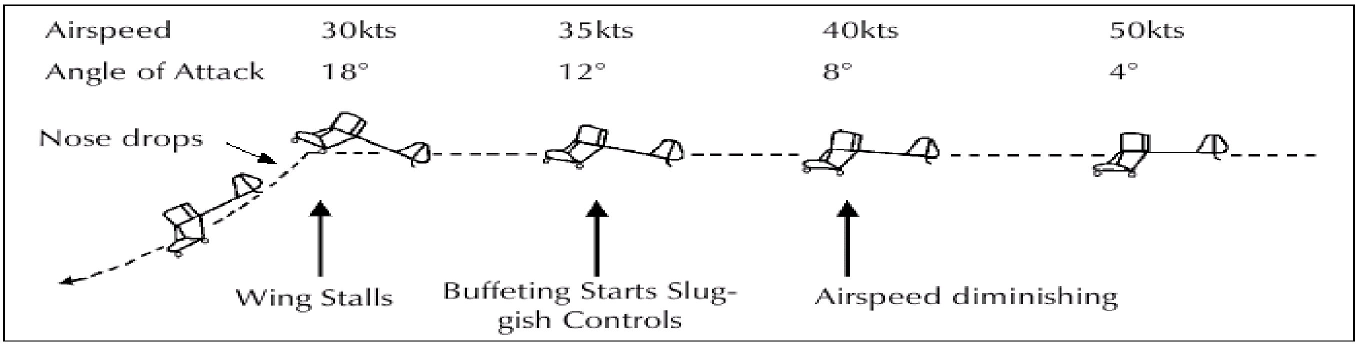

Fig. 29 The Wing Drop

At the point of stall, if one wing produces more lift than the other, one wing may drop. The nose will yaw towards the lower wing and the nose will drop sharply as the angle of bank increases.
The angle of attack on the upper wing is less than that of the lower wing and this may actually unstall the upper wing. The upper wing is moving faster at a lower angle of attack, the lower wing is moving slower at a higher angle of attack, and this begins a brisk rotation, called autorotation. From this point some microlights may enter a spin, continue auto-rotation or enter a spiral dive.

Recovery from the Stall

All that is required to unstall the wing is to reduce the angle of attack to restore smooth airflow over the wing.
To minimise the height loss of the stall recovery, power should be used to assist. Control will be regained faster with less loss of height. The slipstream over the wing (with tractor mounted engines) may smooth the airflow and help reduce the relative angle of the airflow.
Therefore, recovery is a matter of lowering the nose then applying sufficient power to regain flying speed and control, and recovering from the ensuing dive. Rudder must be used to keep the aircraft straight. If a wing drops at the point of stall, the ailerons must NOT be used to raise the lowered wing as the downward positioned aileron further increases the angle of attack of that part of the wing, resulting in further loss of lift which can result in greater roll and subsequent autorotation . The correct recovery for a wing drop stall is to prevent further yaw with the rudder, then lower the nose and apply full power. As control is regained, level the wing and recover from the dive.

SPINNING

From a stalled condition, some microlights may be capable of entering a spin which is a stalled autorotation. The spin may develop from a stall where there is Associated Yaw. See Figs. 30 & 31. In most microlights, a spin is a fairly unlikely event, usually requiring gross mishandling of te controls. During the spin, the microlight is in a fairly steep nose down attitude, autorotation continue and the airspeed is low, and the aircraft is pitching, rolling and yawing all at the same time.

The dangers connected with spins are:

- Considerable height is needed for recovery.
- Not all microlights are designed for spinning, therefore, check the manufacturer's literature for spin details, including any recommended recovery technique.
- Pilots who have not received comprehensive spin training may instinctively hamper or prevent recovery by incorrect recovery technique.

While the spin is not the most pleasant manoeuvre for some, pilots should be encouraged to get spin training in an aircraft cleared for spinning.

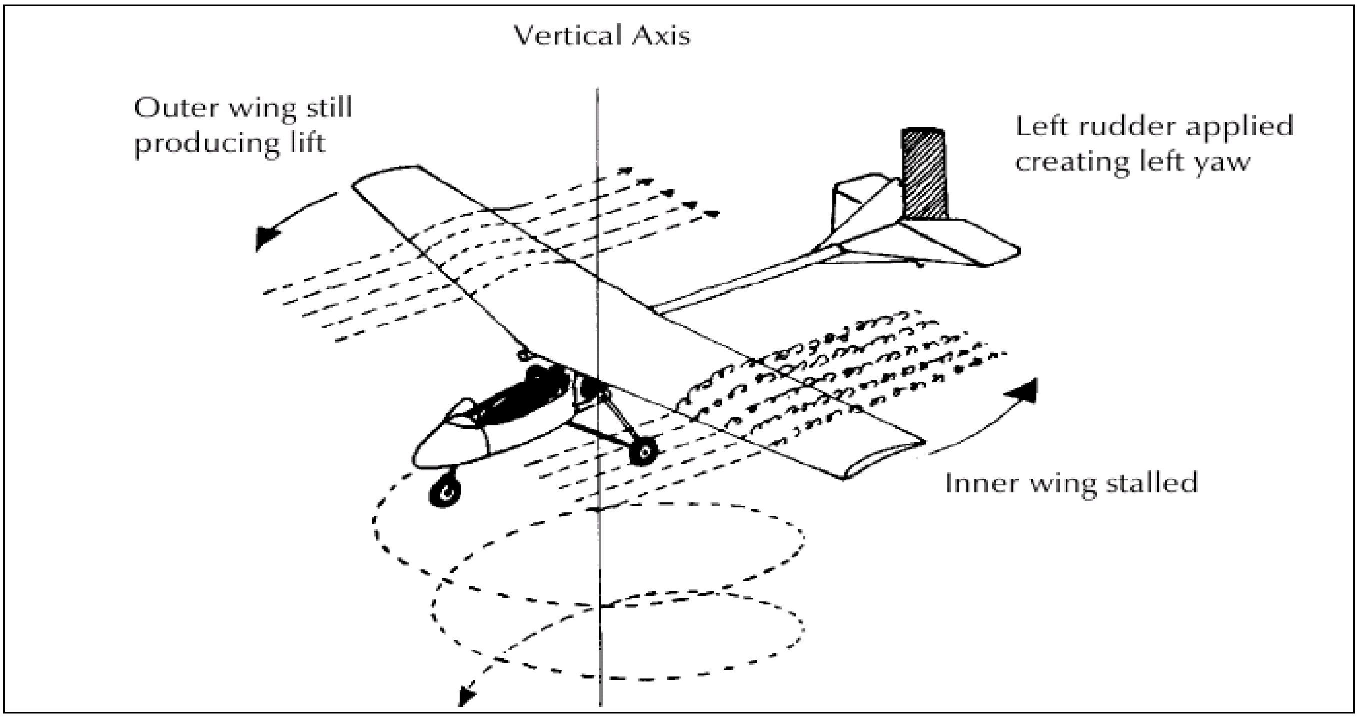

Fig. 30 Spin entry

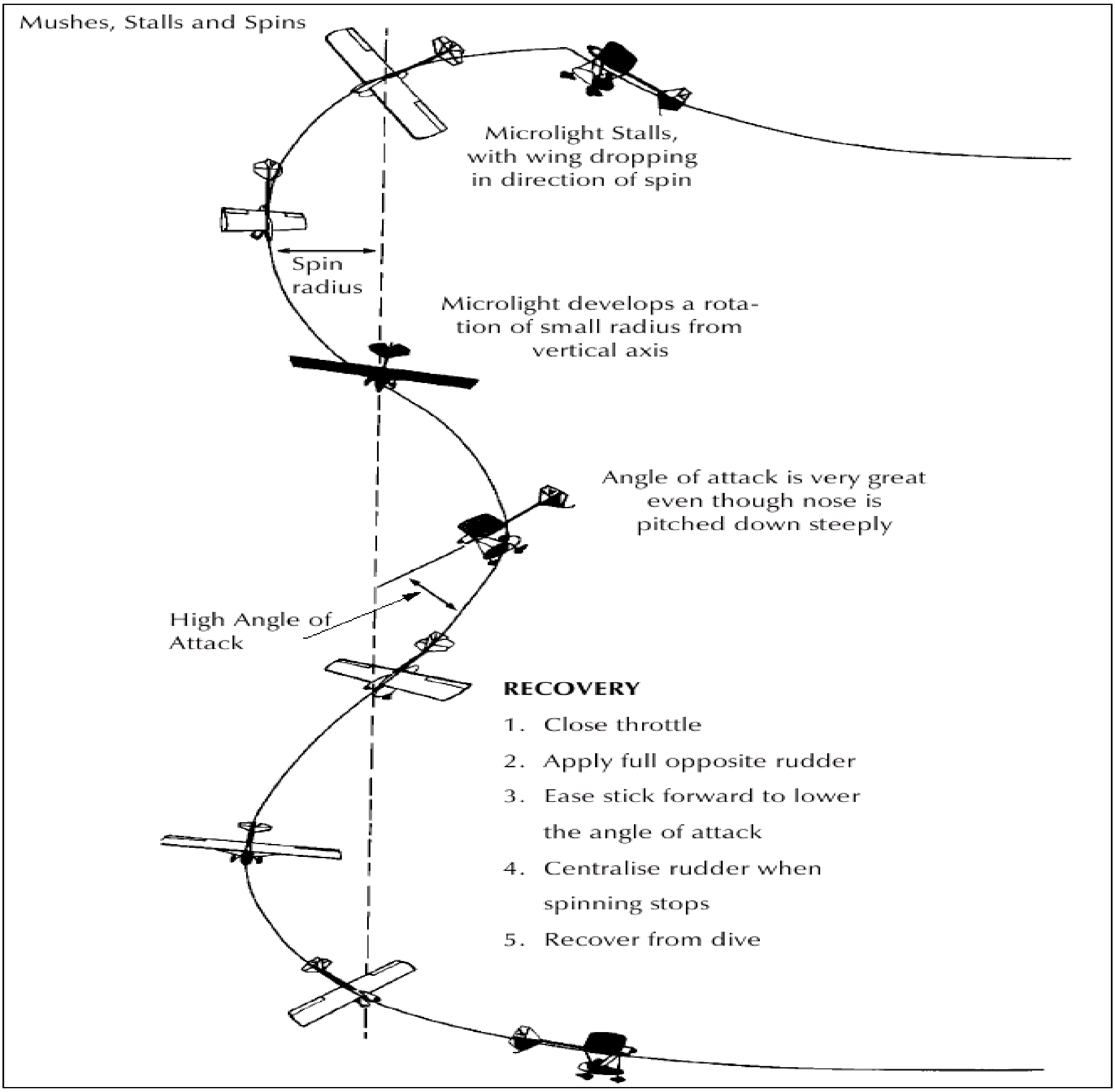

Fig. 31 The sequence of a spin. The microlight is stalled and rotating around a small radius from the vertical.

Since yaw is the cause of a spin, opposite yaw will stop the spin.
Recovery:

- Ensure throttle closed.
- Centralise ailerons.
- Apply full opposite rudder.
- Ease the stick forward.
- When spinning stops, centralise the rudder.
- Level the wings and ease out of the dive.
- Reapply power as the nose approaches the climb altitude.

Note: With a forward centre of gravity, the spin will be steeper and less stable, with easier recovery. With an aft centre of gravity, the spin will be flatter and more stable, with a slower (or even impossible) recovery. Never attempt to spin any aircraft not cleared to do so by the manufacturer, or without proper spin training.
Don't be a test pilot!!!

Factors Affecting the Stall

- Weight: Increased weight (such as passenger and baggage) requires more speed to produce the greater lift needed at all angles of attack. The stalling speed will be higher.
- Power: At high angles of attack, the angle of the thrust line may contribute to the lift. Tractor mounted engines with the slipstream over the wings may help prevent the airflow breaking up and provide more lift.
- Flaps: With use of flap, more lift is produced at a lower airspeed, thus reducing the stall speed.
- g Loading: The stalling speed will increase with loading such as in a turn or during sudden pitching up in a dive recovery.

We have looked at the stall from level flying but, in fact, a stall is possible in any attitude of flight relative to the horizon. No matter where the nose is pointing the aircraft will stall if the wings are presented at too great an angle to the relative airflow.

Further reading: Kermode is recognised as the guru of Principles of Flight.

2. Airmanship

PREFLIGHT INSPECTION

Before any flight the pilot is responsible for ensuring the aircraft's airworthiness for that flight. This entails an inspection of the microlight known as the preflight. The pilot should develop a routine for carrying out this visual inspection and use the same method each time. Some prefer to check specific items in sequence, i.e. engine and prop, then fuel undercarriage, controls and so on. Others may like to start at a certain point, say the nose-wheel, and work their way around the whole aircraft thoroughly until they have gone right round and back to the nose-wheel again.

Whatever method is used, the aim is to satisfy yourself that everything is up to standard and free from defects. An established routine helps ensure nothing is missed. Discovery of a defect means the aircraft must be grounded until repaired and inspected by the appropriate person.

A procedure for completing a preflight inspection is detailed in the X-Team pilot logbook.

If your preflight inspection is interrupted you must start the inspection again.

Preflight should include:

- Pilot documentation: Appropriate pilots certificate, current medical, warm clothing, eye protection and helmet.
- Microlight Documentation: Registration, Flight permit, and radio licence if required.
- Propeller: Propeller integrity, security of gearbox or belts and external bearings and shafts.
- Engine: Security of spark plugs and all electrical leads, throttle movement and cable integrity, choke and ignition switch operation, check all mountings, carburettor and exhaust for cracks and security.
- Fuel: Correct mix, sufficient for flight plus reserve, filters for contamination, fuel lines for hardness and integrity fuel cock operation, check fuel drain for contamination.
- Controls: Correct and full movement, cables, pulleys, rods and hinges for excessive wear.
- Airframe: Integrity of structure, i.e. no cracks and dents in tubing, or sloppy bolt holes, or loose nuts/bolts, security of internal bracing wires, fabric not ultra violet damaged or ripped, no kinks or broken strands on wires/cables. Check locknuts, pins and locking wire security.
- Undercarriage: Security of, integrity, tyre condition and inflation.
- Instruments: Operation. Setting. Security.
- Miscellaneous: Seating and harness integrity, baggage security.
- Airstrip: Length sufficient, surface suitable, no obstacles.
- Weather: No rain, wind less than 75% stall speed, crosswind within capability of microlight pilot. Cloud amount and type base height. Weather forecast for period and route of flight.
- Map/s: Airspace, flight route, terrain, height of obstacles.

Note:

- If the machine requires fuelling, do this before the preflight check.
- Sight down tubes this makes bends or kinks more apparent.
- Using a rag to protect your fingers, run your fingers along cables checking for any kinks or broken strands. Ensure windscreen and propeller are clean.
- Watch for missing locking pins and sufficient bolt thread showing through nuts, elongation of bolt holes, cracks and wear.
- Secure baggage before preflight so controls operation and freedom can be checked.
- Physically move controls and control surfaces to check for proper operation and attachment.
- Do not allow scarves to trail loose and check for loose clothing, particularly if the prop is behind. Detachable helmet peaks and visors can easily come adrift in flight.
- Do not adopt a casual approach to defects! Ensure they are reported and attended to.

GROUND HANDLING

Proper control of the microlight on the ground is important, as a large proportion of the damage to aircraft is suffered whilst taxiing or during the takeoff or landing roll. Perhaps the most important thing to remember is that the microlight is a lightweight aircraft with a relatively large wing area, meaning that any surface wind can have a powerful effect on it.

Proper handling of the microlight on the ground involves:

- Positioning your aircraft before startup to minimise the effects of prop blast on other aircraft and open hanger doors behind your aircraft.

- Making sure all bystanders, pets etc are a safe distance from the aircraft before startup, then call "Clear Prop".
- Correct use of power.
- Keeping to a safe speed for the conditions.
- Correct positioning of the controls.
- Consideration for obstacle clearance and braking.
- Keeping a good lookout.

Correct use of power. To get the aircraft moving, a fairly large amount of power may be needed.
Once moving however, only a reduced amount will be required. Microlights without nose wheel steering rely on the slipstream acting on the rudder to assist directional control. Care must be taken to use sufficient power when needed to carry out the turn, but not for long enough to increase taxiing speed dangerously.
Keeping a safe speed for conditions. Special care must be taken when taxiing (in even moderate wind conditions). A brisk walking pace is acceptable in calm conditions, however a fast taxi into a head wind could bring the microlight close to liftoff airspeed, whilst control response may be insufficient to counter the effects of gusts etc. Beware of taxiing too fast downwind as braking distance increases and control response may be nil with reduced slipstream over the control surfaces (nose-wheel steering microlights are generally easier to manage).
Of course fast taxiing over rough ground can do considerable damage not only to the undercarriage, but the entire airframe, as the shocks and vibrations are absorbed. Take particular care over rough ground, and if necessary shut off the engine and manhandle the microlight through the rough areas. Allow for gentle radius turns and avoid sharp turns at speed. Turning out of wind (i.e. turning left from a position with a right crosswind or turning from upwind to downwind), may require a greater turning radius as the wind on the rudder surface counters the turn. More power will probably be needed out of wind.
Correct positioning of controls. Always bear in mind the relative airflow of the wind over the whole microlight while taxiing. Depending on the type of microlight and the control system, position the controls as required to avoid the wind picking up a wing, turning the microlight or nosing over. Check with your instructor as to what is required for your aircraft. For a conventional aircraft, Fig. 1 shows the use of controls while taxiing in wind.
Approach all obstacles gently. Allow plenty of room to slow down and stop. Taxiing downwind requires more braking distance. Remember to ensure the wingtips are well clear of obstacles. Avoid taxiing close to people, buildings, vehicles, fences, trees, etc.
Keep a good lookout. Although you are still on the ground, you must maintain a SHARP LOOKOUT for other aircraft which may be taxiing, taking off or landing. If operating without a radio from a controlled airfield don't forget to watch for light signals from the tower.

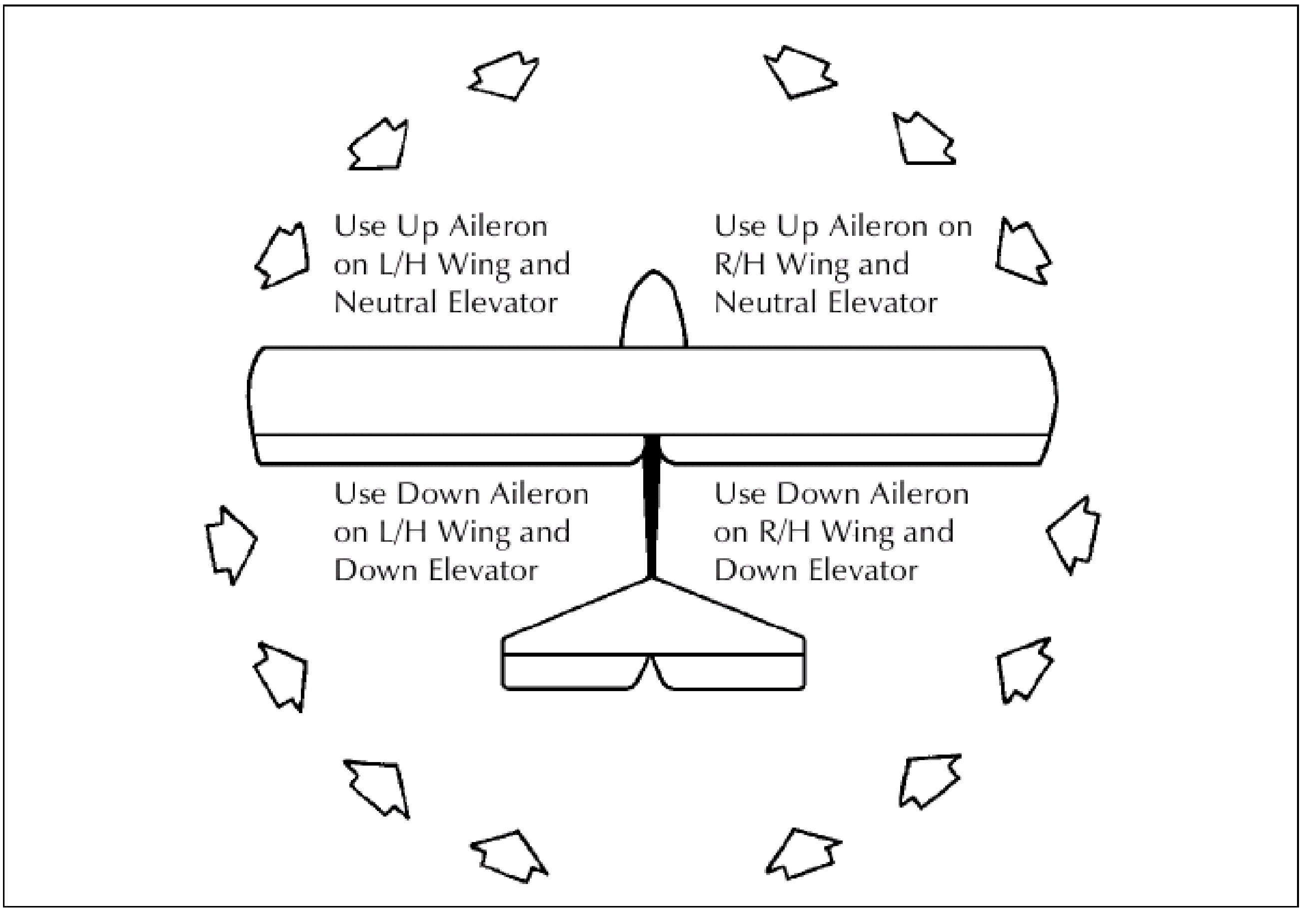

Fig. 1 Correct positioning of the controls for taxiing in wind.

TAKEOFF CIRCUIT AND LANDING

General

Most microlights takeoff and climb so readily that it is easy to forget that this phase of flight includes hazards associated with flying near the ground (albeit briefly) at low airspeed.
Good pilot technique includes careful consideration of the following factors which affect the performance of any microlight:

- Air Density: A lower air density will extend the takeoff roll because it decreases the performance of the engine and prop and the lift developed by the airfoil. Air is less dense when it is hot, or moist, or at higher elevation, or at lower pressure.
- Weight: The heavier the microlight the more lift is required to offset it. Therefore, the lift of speed and distance will be greater, and with a slower acceleration.
- Runway Surface: The ideal surface would be smooth and hard, such as concrete or asphalt, which allows a faster acceleration and thus a shorter takeoff roll. Tall grass, especially when wet, severely hampers acceleration. Surface water (puddles) cause a lot of drag, with the added prospect of water being thrown up, damaging the prop and causing the belts to slip.
- Runway Slope: A downhill slope allows a much faster acceleration, while an uphill slope will extend the takeoff roll alarmingly! It is generally better to takeoff downhill where possible.
- Wind: Taking off into a headwind means liftoff airspeed will be reached after a shorter ground run, and liftoff occurs at a lower groundspeed. Wind speed should not legally be greater than 75% of the microlight's stall speed.
- Obstacle Clearance: With all factors in mind, there must be no doubt that all obstacles can be easily cleared. If there is any doubt, stay on the ground until conditions improve sufficiently, or disassemble and trailer the microlight to another field. Remember, obstacle clearance includes things on the climb-out path it is no use blasting out of a paddock with room to spare if you can't clear safely something else further on.

Having considered the factors of performance, there are a couple of other points which must be dealt with:

- For the wind conditions, what objects, if any, are going to be possible causes of wind shear or turbulence both during and after takeoff? (See Turbulence section.)
- Is the terrain on the climb-out path suitable for a forced landing in the event of an engine failure?
- Where are the best areas?
- Is your initial climb-out going to upset people or stock? Remember the laws about flying near people.

Takeoff

Assuming all is well with the microlight and conditions, we can taxi out toward the runway. Before taxiing onto the runway the following checks should be carried out:

- Controls are checked for full, free and correct movement. Choke off.
- Harness and Helmet on and secure, no unsecured objects. (Hatches closed.)
- Ignition switches on and instruments functioning and set. For dual ignition motors check rev. drop between ignitions.
- Fuel sufficient for flight plus reserve, turned on and checked for correct mix and contamination. Flaps (if used) set.
- Throttle functioning correctly through full power range. Trim set, if fitted.
- Airfield Lookout prior to moving on to the runway. Approaches clear of traffic.

The lookout on the ground is probably best achieved, where possible, by making a 360° turn to allow a more complete view of the whole area.

- Never move onto the active runway until all checks are completed.
- Always use the full length of the runway available.
- The object of the takeoff roll is to accelerate on the ground until liftoff airspeed is attained.
- Liftoff airspeed is a speed that enables the microlight to become airborne with good control response. It can be possible to achieve liftoff below the ideal speed, (with the aircraft flying in "Ground Effect") but this can put the aircraft in a vulnerable position for a few moments, as control response may be limited to counter gusts, etc. It is better to lift off at a comfortable airspeed that ensures a positive rate of climb can be established immediately. Of course, holding the microlight on the ground for too long is no good either.

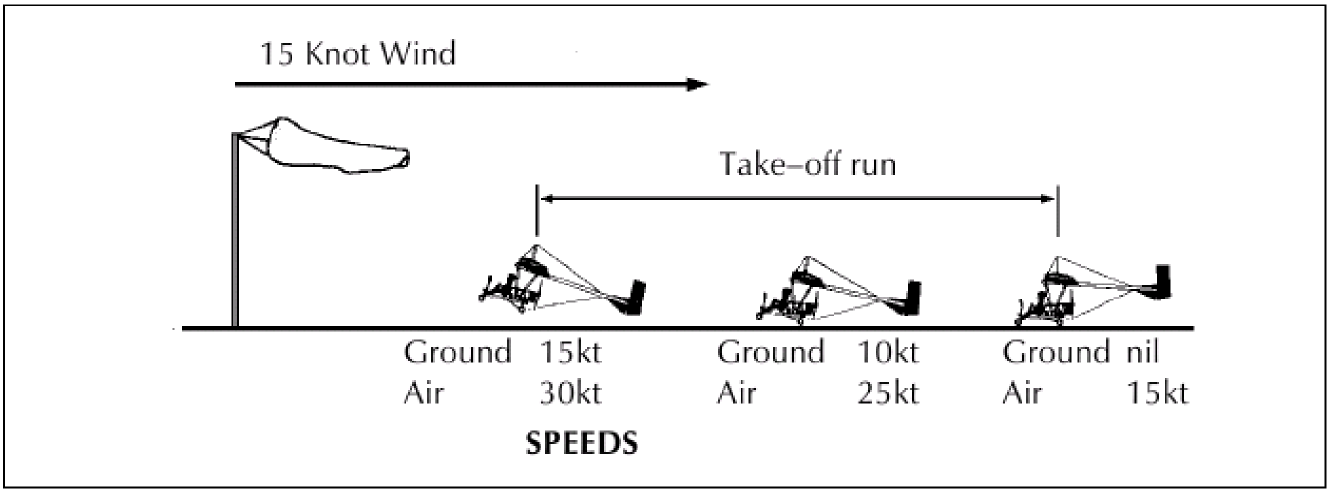

Fig. 32 The effect of a 15 knot headwind on the takeoff run.

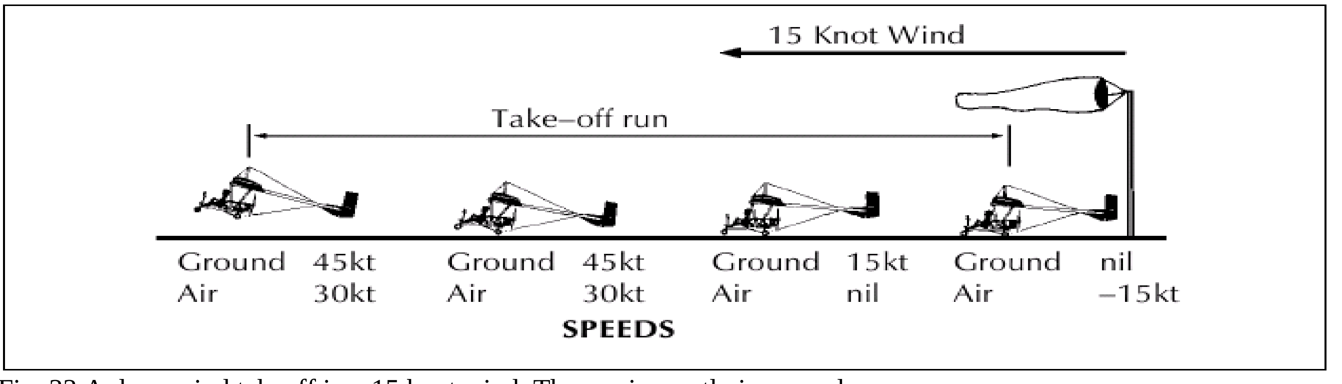

Fig. 33 A downwind takeoff in a 15 knot wind. The run is greatly increased.

Line up on the runway and smoothly apply full power, keeping the aircraft straight.
As the airspeed increases, the controls will begin to have effect. At the appropriate airspeed we can become airborne, carefully lowering the nose if necessary, to build up to the climb speed, while in ground effect (within one wingspan height). Then the climb should begin.
It is vital that careful attention is paid to maintaining the correct climb speed. Using FULL POWER and correct recommended climb speed, ensures a safe climb-out can be made to 500ft altitude.
Never haul the microlight off the ground and point it skyward at some incredible angle and expect it to get a spectacular climb. The result would be an initial zoom after liftoff, followed by a very rapid loss of airspeed and stall and, not surprisingly, there is unlikely to be sufficient height for recovery!!
Remember, use the recommended climb speeds to give the best attainable climb performance. Something else to consider is the consequence of an engine failure shortly after takeoff. With the high nose attitude and low airspeed of the climb, should the engine fail, a rather positive nosing down of the microlight will be needed to maintain safe airspeed.
If the engine failure occurred in a steep climb at low altitude, there may actually be insufficient height available to lower the nose, restore airspeed and arrest the considerable rate of descent at the flare of landing. The result could be a very heavy landing or crash. The cure is simple refrain from an initial steep climb until a safer height is reached, at least 300ft AGL. This is especially so for two place microlights, with their higher wing loadings and inertia.
During the takeoff roll make sure you are getting the full power selected, and that acceleration is normal for the conditions. Keeping a straight roll is vital.

The Circuit

The circuit is a rectangular path flown by aircraft around an airfield or runway. Generally, all turns in the circuit are made to the left for powered aircraft, unless specified right.
With all traffic adopting the circuit pattern it is very much easier to sequence aircraft for takeoff and landing because one can observe another aircraft in the circuit and predict it's subsequent likely actions.
The actual physical dimensions of the circuit may vary between pilots, machines and airfield, but there is a uniformity of traffic flow. Thus, a number of aircraft can operate, even without radio, in an orderly and safe manner. It is important, therefore, that the circuit you fly is tidy and you consider other airspace users.

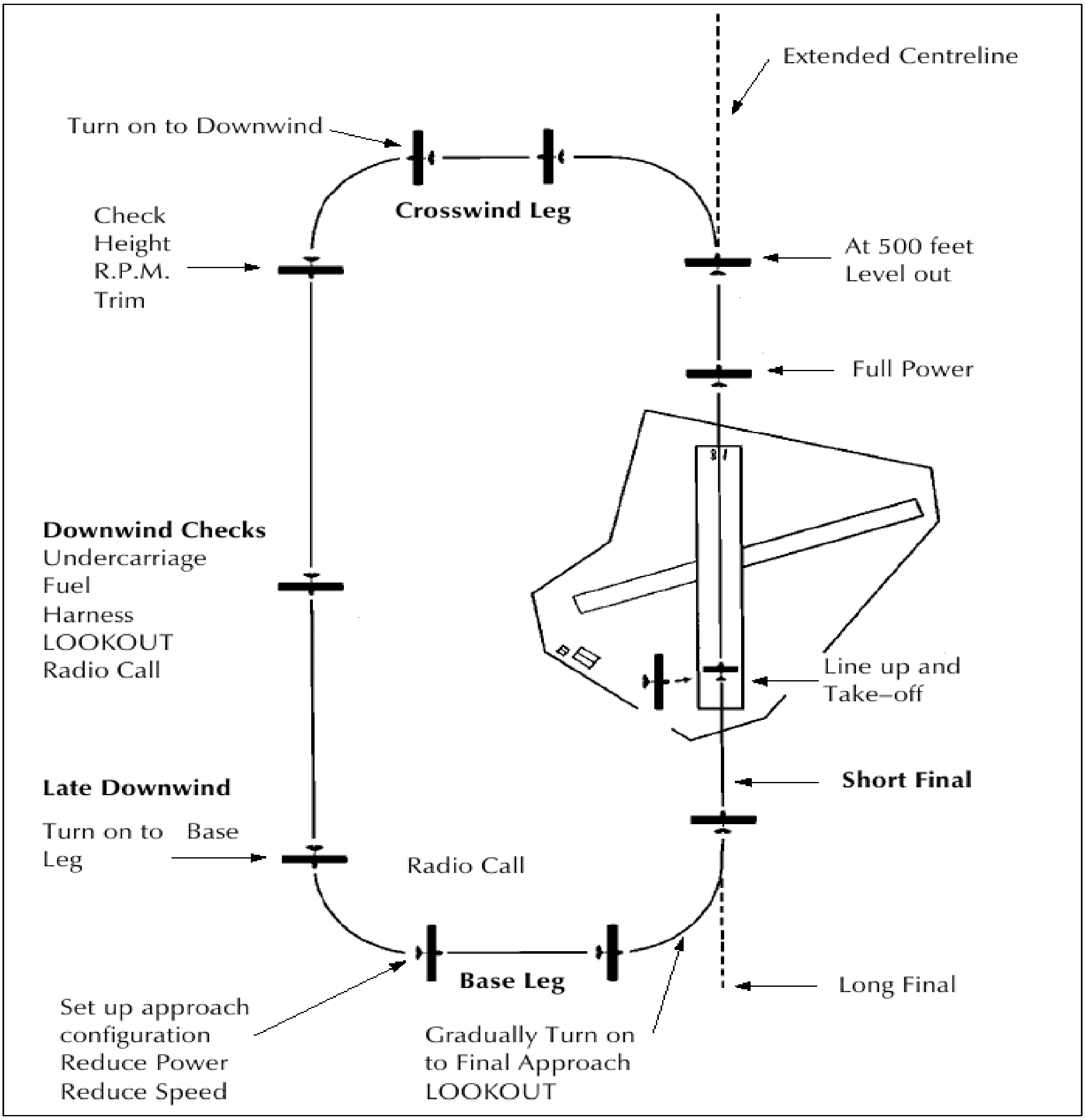

Fig. 34 The Normal Left Hand Circuit.

After takeoff, we climb under full power to the normal microlight circuit height of 500ft above ground level (AGL), taking care to maintain ground track on the extended centre-line of the runway. (General Aviation aircraft circuit height is normally 1000ft AGL.)
Upon reaching 500ft we level out, looking for other traffic and turn left to a ground track 90° to the runway heading. This is the "crosswind leg" or in this case called "left crosswind" for our left hand circuit.
From the crosswind leg we have to position ourselves on the "downwind leg" (left downwind here). Another left turn brings us parallel with the runway, downwind.
Where possible, the downwind leg should be flown within gliding distance of the runway in case of engine failure. However, not too close so as to cramp the circuit.
On the downwind leg, check height, speed and engine RPM. Also check the windsock for wind direction and strength and the airfield for obstructions.
Carry out the pre-landing checks, which should include:

- Undercarriage down and locked, brakes off (if applicable).
- Fuel check quantity, sufficient for another circuit plus 20 mins reserve, selected to the appropriate tank (if applicable).
- Harness secure.
- Lookout for other traffic.
- Normally a radio equipped microlight would make a radio call mid downwind and prior to turning final.

Care must be taken not to cut in front of other traffic in the circuit, so although it would be desirable to make the next turn onto base leg, (left base), while still within gliding distance of the runway, it may be necessary to extend downwind to allow for other traffic ahead.
One more left hand turn onto "final" brings us back onto the extended centre line of the runway, into wind and ready to land.
Before discussing the final approach to landing, a few points on the circuit:

- Keep a good lookout.
- Fly a rectangular circuit, allowing for wind drift as required.
- Don't skip pre-landing checks.
- Check the windsock and airfield on downwind.
- LOOKOUT.

Final Approach

A well executed approach places the microlight in the ideal position, at the ideal speed, from which to make a landing.
The approach involves controlling the rate of descent and airspeed to allow landing at a chosen position on the airfield.
Remember when setting up an approach:

- Pitch control governs the airspeed.
- Power controls rate of climb and descent.

Speed Control

The landing itself, whenever possible, involves touching down with the least possible groundspeed and at an airspeed low enough to ensure that the microlight has really quit flying once it is on the ground.
Therefore, arriving at the right height over our aiming point on the runway without excessive speed means less runway will be used in landing. By the same token, too slow an approach speed could place the microlight near the stall with poor control response and maybe insufficient pitch control left to arrest the descent.
So, obviously, each type of microlight has an ideal approach speed for normal conditions. This speed is probably something like the best climb speed.
As mentioned above, control the airspeed with elevators (pitch control). We will discuss varying the approach speed for the conditions later in the section. Speed control is important, particularly in the latter stages, where a stall near the ground could be disastrous, or too much speed could greatly increase the runway length needed.

Approach Angle

The angle of the final approach is important and is a product of the rate of descent and the airspeed, as well as the wind factor. If the approach is made from too low (shallow angle), the dangers are that of undershooting, being near the ground for longer than necessary and therefore being subjected to mechanical turbulence for longer. An engine failure on this approach would mean little or no chance of reaching the runway and an extremely limited choice of alternatives.

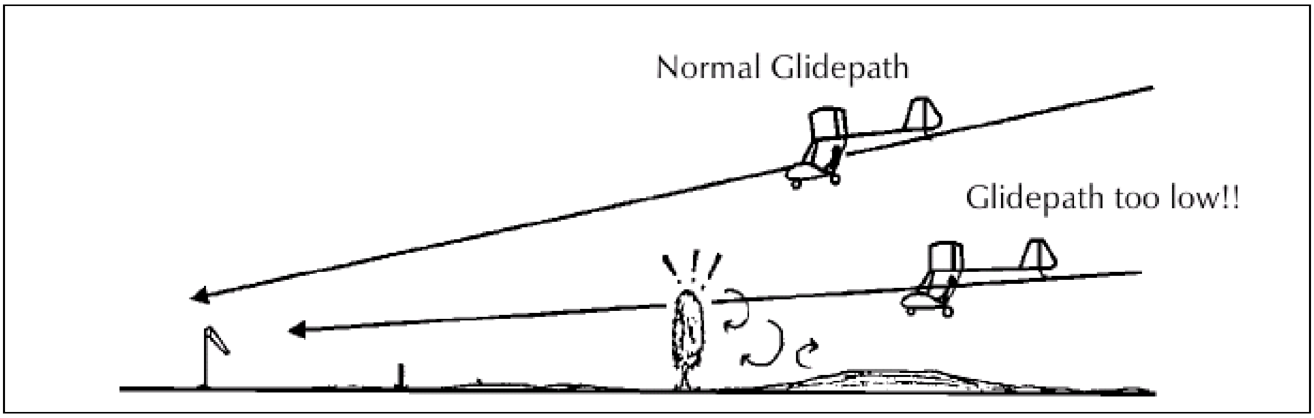

Fig. 35

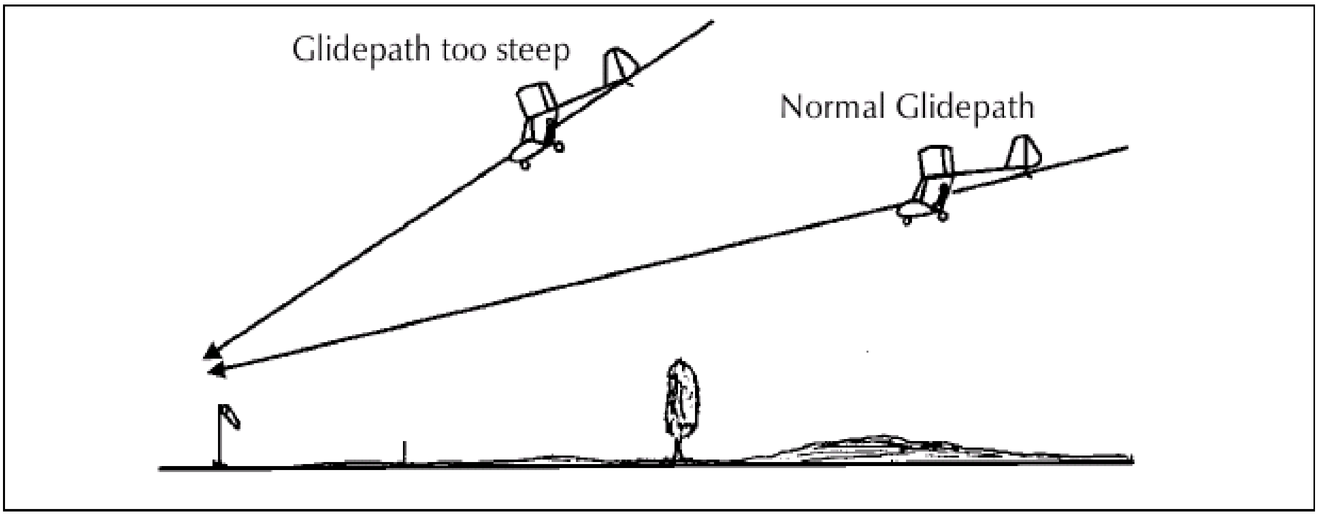

Fig. 36

This final approach angle, known as the glide path, is an imaginary line down which the final approach is flown to touchdown. It is on the extended centre-line of the runway. With your instructors help you will learn the normal glide path.

Flying down this glidepath involves:

- Maintaining the proper speed.
- Keeping to the extended centre-line.
- Exercising height control to keep to the glide path.

To help with judging progress down the glide path are two visual clues commonly in use:

1. When operating from a runway, if you are too high the runway will look tall and long:

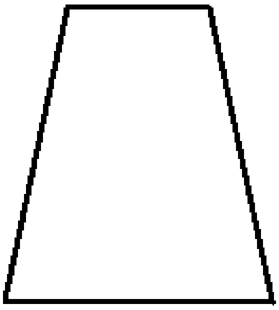

Fig. 37a

If you are too low it will seem to flatten out:

Fig. 37b

The normal approach glidepath will look something between the others, thus:

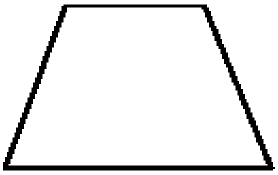

Fig. 37c

2. The second uses a point on the microlight to assess progress down the glide path.

Once positioned on the glide path, line up a point on the airframe ahead with your aiming point on the ground. If this point on the airframe starts moving up the runway during approach then you are getting too high. Conversely, if it moves back off the runway, you are becoming too low.

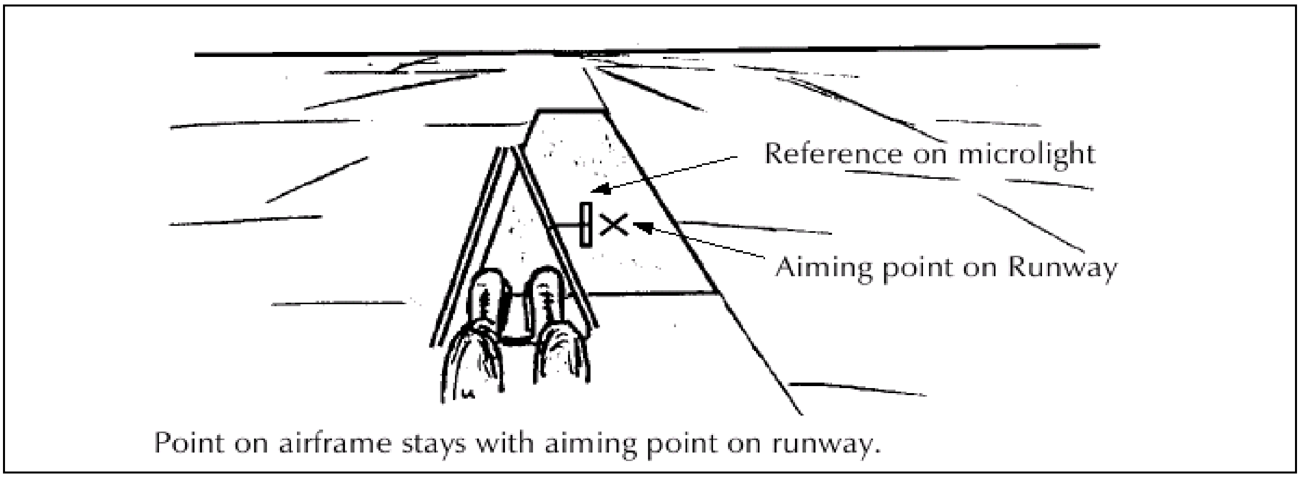

Fig. 38 On Glide path.

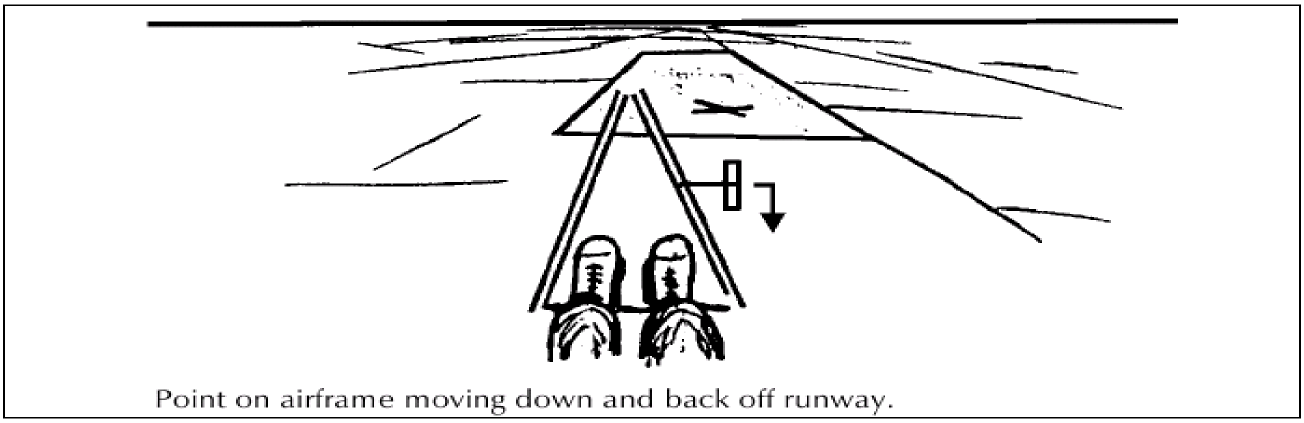

Fig. 39 Becoming too low.

If you notice you are sinking below the glide path, power is required to retrieve the situation; apply power and raise the nose maintaining the approach speed.
When back on the glide path, lower the nose and reduce power again as required to maintain the glide path and correct speed.

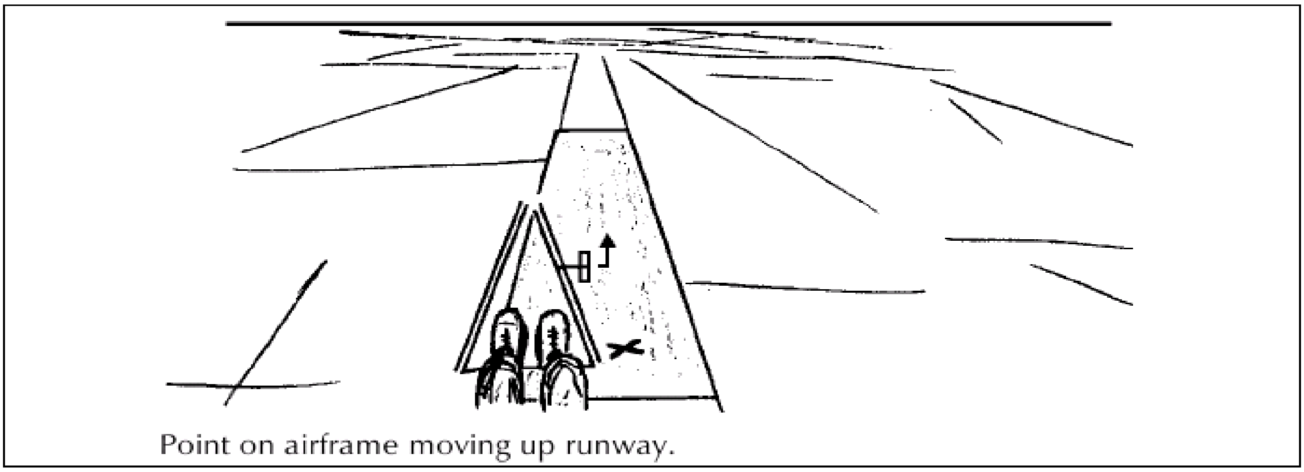

Fig. 40 Becoming too high.

In the event of becoming too high, reduce power and lower the nose to increase the descent maintaining the approach speed.
Once back on the glide path, resume the power and speed to hold it.
Small corrections made early make things very much easier.
If the approach goes badly wrong, do not hesitate to abandon the landing, apply power and overshoot for another circuit.

Factors Affecting the Glide path

- Wind as already mentioned, wind strength and direction. (See Flying in Wind section.)
- Areas of Lift and Sink Lift and Sink produced by convection current activity and wind flow over terrain.
- Wind Shear Discussed with lift and sink in the turbulence section.

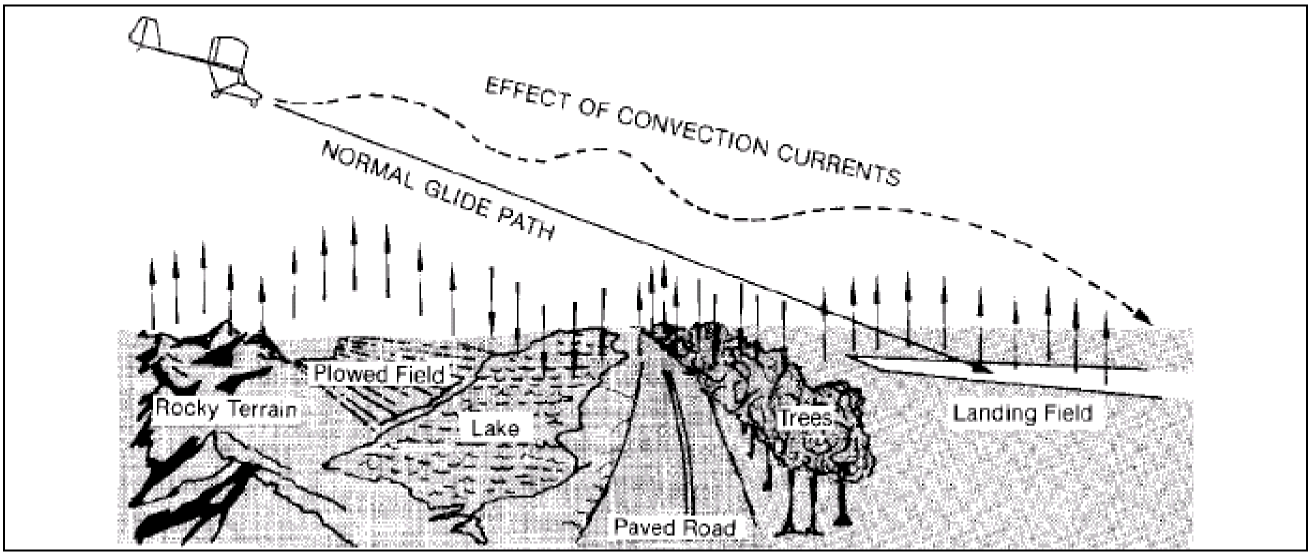

Fig. 41 Effect of Convective or Thermal turbulence.

Assuming we have flown a good approach, we are ready to land the microlight. As mentioned before, this is a matter of touching down with the least forward speed, in a gentle fashion we hope!!

Landing

During our approach we hold the right airspeed and descend at a moderate rate. During the landing sequence the following should occur. As we near the ground (often at around wingspan height) the nose is raised slightly to slow the rate of descent. This is called roundout.
When correctly timed, the roundout places the microlight a foot or two above the ground, ready for the flare. Generally, the power is off in the flare.
The aim is to achieve level flight just above the ground, progressively raising the nose to do so.
As the airspeed drops, the microlight will be unable to remain airborne, and will settle on to the runway.
Of course, during this phase of flight the microlight must be kept straight. Every landing requires special attention, especially in strong or variable winds. Be ready on the controls to counter any effects of fickle winds, remembering that at reduced speed control response will be less.

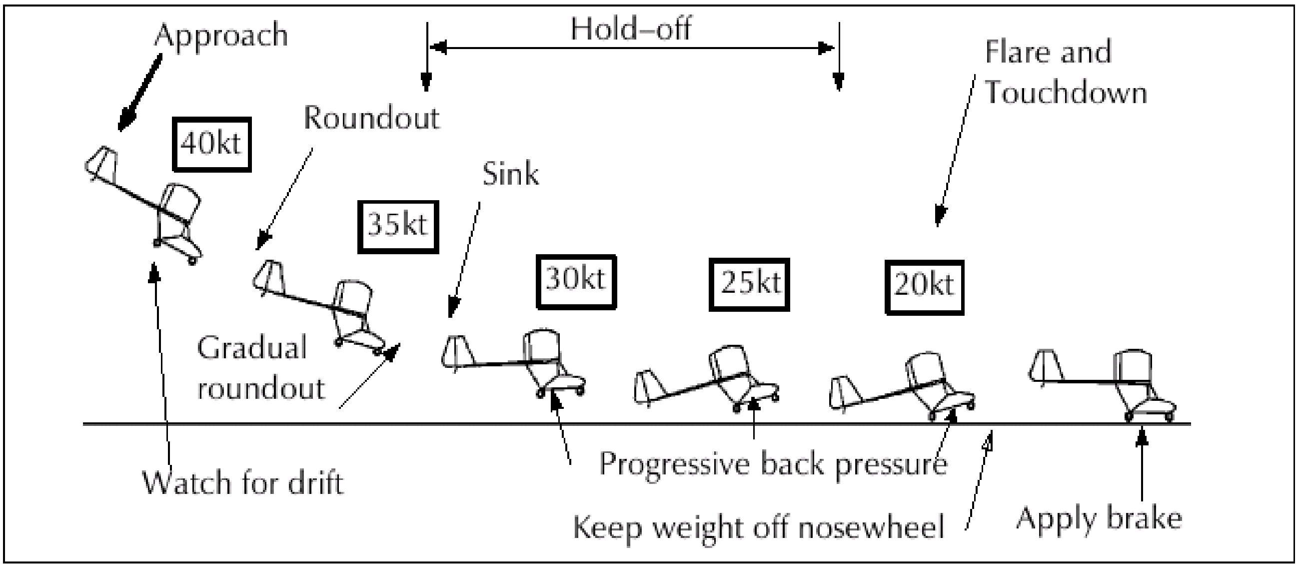

Fig. 42 Typical landing sequence for nose-wheel aircraft.

After landing, wherever practical, turn off to the left. If operating from a field land to the left if possible, leaving room for al owing traffic to land on your right, anticipating your left turn after the landing roll.

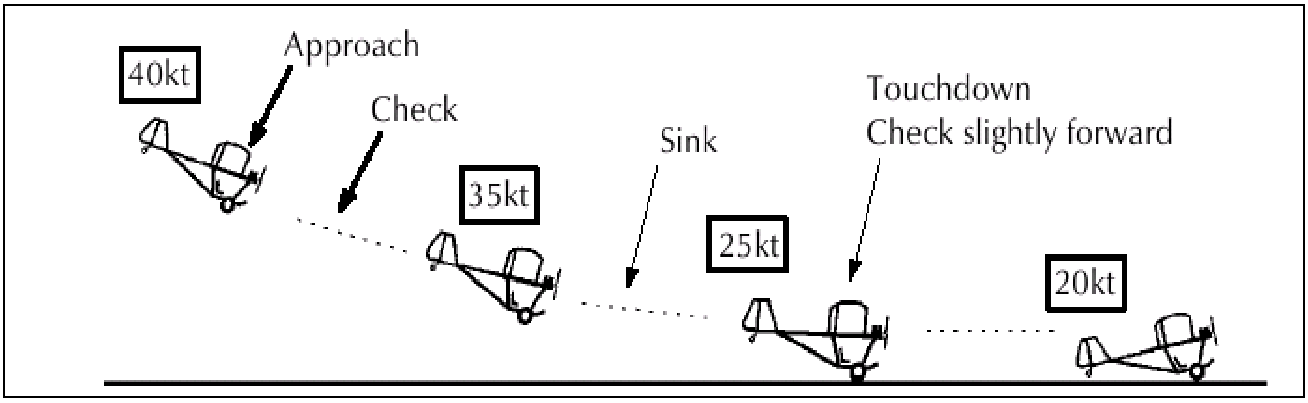

Fig. 43 Typical wheel landing (Tailwheel microlight).

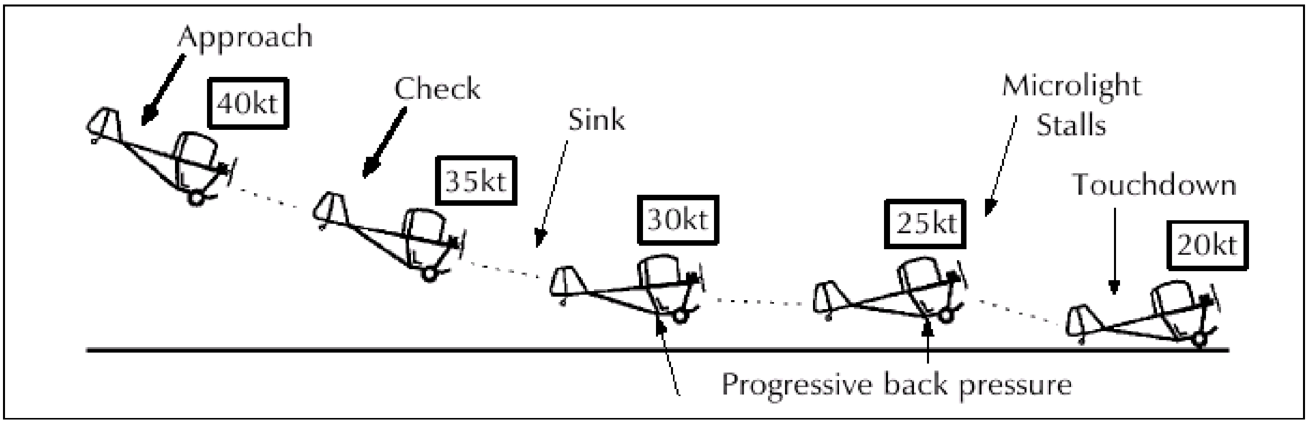

Fig. 44 Typical three point landing (Tailwheel microlight).

Notice the lower touchdown speed for the three point landing compared to the wheel landing.

EMERGENCY PROCEDURES

As engine failures in microlights are a constant possibility for which every pilot must be prepared, especially as the occurrence of failures to date is quite high, an immediate and correct response to engine failure is essential.
Very much in the microlights favour is the fact that most microlights glide fairly well and are capable of a safe landing in a small field. This, in addition to a skilled pilot, should give every chance of a happy outcome to what can be a traumatic experience for the ill prepared.
A simple rule which should be adhered to, is to always keep within gliding distance of a suitable emergency area and to have one in mind at all times.

Complete Power Loss

In the event of an engine failure at circuit height (500ft AGL) or below, there is in likely to be sufficient time to remedy the engine problem without seriously distracting from the task of performing a forced landing. For this reason, an engine failure at low altitude should be considered permanent, the throttle closed and all concentration given to the landing. After all, the engine may be beyond starting again, and to attempt a restart at the expense of planning a landing is foolish. At higher altitudes, once the forced landing is planned and set up there may be time to attempt a restart.
Therefore, in the event of engine failure at low altitude or in the circuit:

- lower the nose, maintain gliding airspeed.
- check the wind direction and strength.
- choose your emergency landing field (at this height it will be practically right below or very near.
- plan your descent.

If time permits, then check:

- Fuel supply to engine.
- Choke off.
- Ignition.

"Do not mess up an approach because of an engine restart attempt!!"

Engine failure during take off roll

Unless the field you are using is very short, an engine failure before liftoff should allow room to roll to a stop before the end fence. If there looks to be insufficient distance ahead it may be best to initiate a ground loop.

Engine failure during climb-out

There may be enough runway left to land ahead, otherwise make a landing further ahead. Should the failure occur further in the climb there is little or no prospect of returning to the airfield because:

- Considerable height is needed to complete the 180° turn back. In haste the pilot could easily stall the microlight. Also the groundspeed at touchdown will be higher with any tailwind component.
- Having taken off into a headwind you are better off to land ahead into wind, even on a rough surface, because the touchdown groundspeed will be lower.

Engine failure in the circuit

Where possible a circuit should be flown close enough to allow a safe glide back to the airfield from the mid downwind position, should the engine fail.
Prior to the mid downwind position, landing back on the runway into wind is unlikely, therefore the pilot must choose the best area easily reached, preferably into wind.
In a future section, we shall look at engine failures at altitude.

OVERHEAD REJOINS

When arriving at an airfield the standard circuit rejoin procedure is used to join the circuit safely.
It is used for all unattended aerodromes and may be required by Air Traffic Control at attended aerodromes, even if the microlight is equipped with radio or if you have a radio failure at a controlled airfield.
Being thoroughly familiar with the circuit procedure is important to avoid dangerous confusion in the circuit. You can ascertain from a Visual Flight Guide (VFG) the circuit procedure for registered airfields. Although left hand circuits are normal, most airfields have a combination of left and right hand circuits operating for a variety of different reasons. Check with your instructor if you are not sure.

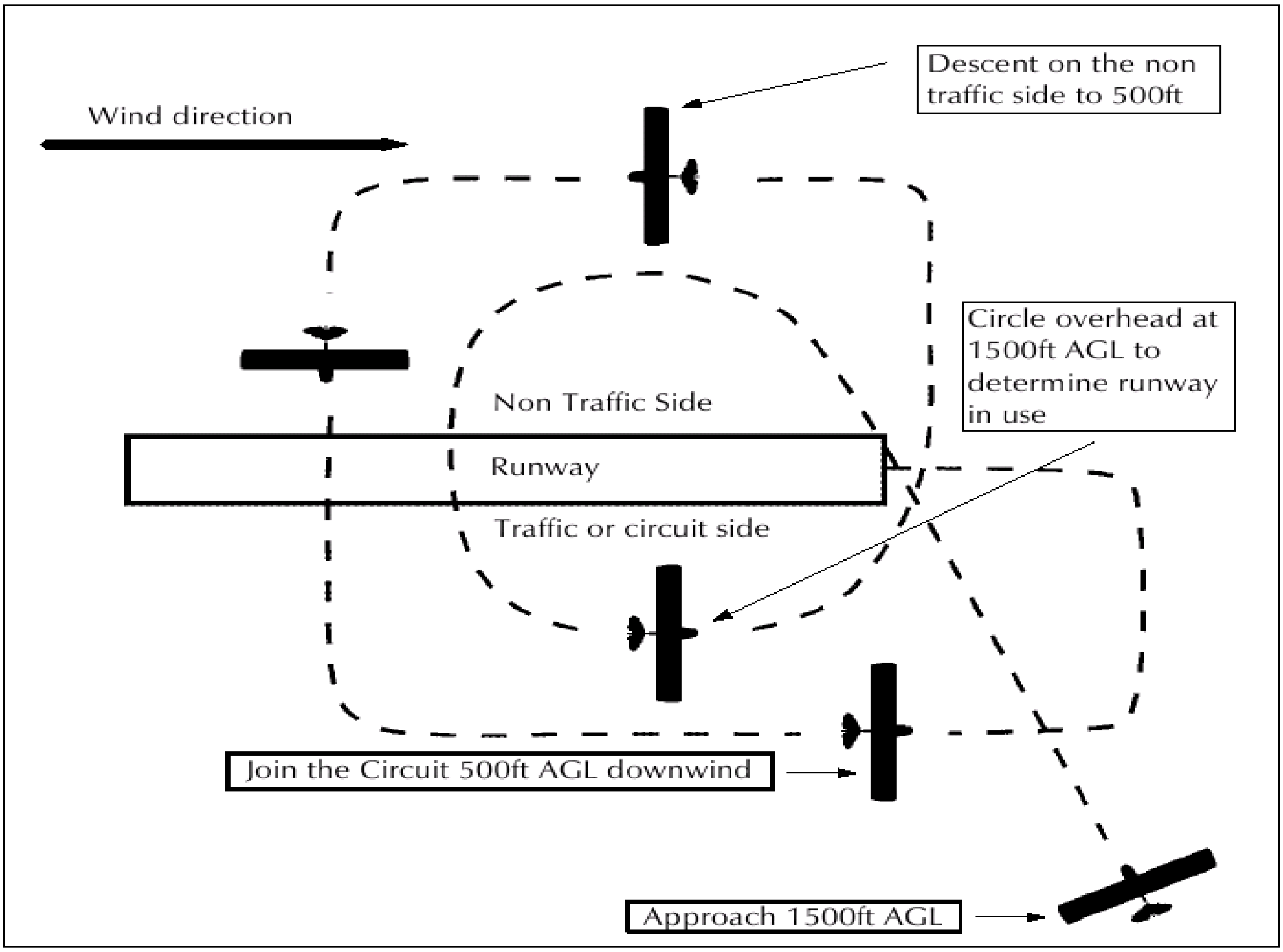

Fig. 45 Standard Overhead Rejoin.

The aerodrome should be approached 1500ft above ground level (or 500ft above circuit height).
When arriving overhead check for other traffic, then determine the wind direction and runway in use. This is done while circling overhead in a left turn, unless ground signals indicate a right hand circuit in use.
This circling turn can continue until the pilot is sure of the wind, runway to be used and other traffic. A turn or two extra to get things properly sorted out in your mind is no disgrace at all.
When sure of things, it is time to descend to the circuit height of 500ft above ground level. This descent must take place on the non-traffic side of the circuit.
The side of the runway over which the circuit is flown is known as the traffic side of the runway.
Once down at circuit height, cross the runway at a position that will allow any high performance aircraft to clear you (this may well be 2/3 or 3/4 way down the runway) and then join the circuit downwind and continue in the normal manner.
NOTE:

- A good lookout is vital when rejoining the circuit.
- Windsocks are generally located on the left hand side of the runway threshold.
- Remember General Aviation aircraft will be flying at 1000ft AGL.
- When contacting an Air Traffic Control Unit to fly into a controlled airfield, ensure that the circuit height to be used is established, as some may prefer a 1000ft circuit be flown.
- Take into consideration the very much higher speeds flown in the circuit by larger aircraft as well as their wider circuit.

Glide Approaches

Glide approaches are taught to give the judgement needed to make an approach without power, touching down at a desired point. Usually a normal circuit is flown but at the late downwind position the power is brought back to an idle.
In order to judge the approach so as to touch down at 1/3 of the way into the airfield, we must consider the effects of:

- The microlight's airspeed on its glide angle.
- Wind.
- Wind gradient.
- Lift and sink on the glide path.

The Speed adopted in the glide is very important. The best lift to drag ratio speed ensures the most distance is covered horizontally for the least height lost, so naturally this is the ideal speed. Gliding above or below this airspeed will reduce the glide range.
Wind As discussed in the Effect of Wind section, the stronger the headwind, the steeper the glide path. See Figs. 46 & 47.
Wind Gradient Descending into reducing wind speed will reduce the gliding range as the nose is lowered to maintain the airspeed and as a result, the glide path will steepen. See Fig. 48.
Lift and Sink encountered on the glide path will alter the approach. See Fig. 41.
Aiming to land at least 1/3 into the runway helps allow for the effects of unexpected sink or deterioration of the glide path. The judgement required for the glide approach into a small field is considerable, but a very worthy skill to strive for. See Fig. 49.
Steep angles of bank greatly increases the stall speed and also increases the sink rate, causing a large loss of height. Avoid all steep turns near the ground.
Warm the engine periodically or as recommended. When there is medium to strong wind, do not get too far downwind of the field as glide cannot be stretched!

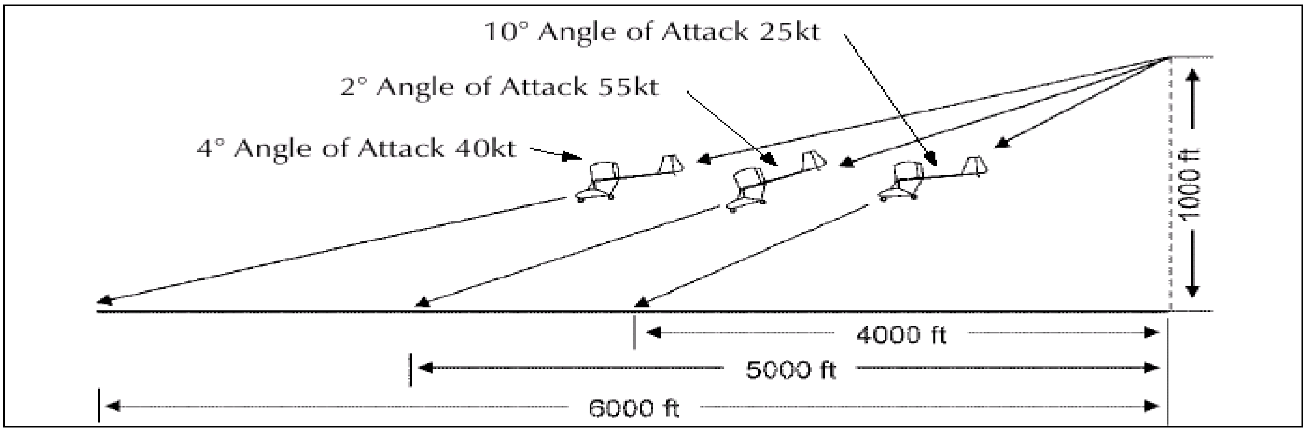

Fig. 46 The effect of airspeed on the angle of glide. At 25 kt the microlight sinks rapidly. At 55 kt height is lost in a gentle dive. 40 kt is the best L/D speed for this particular microlight.

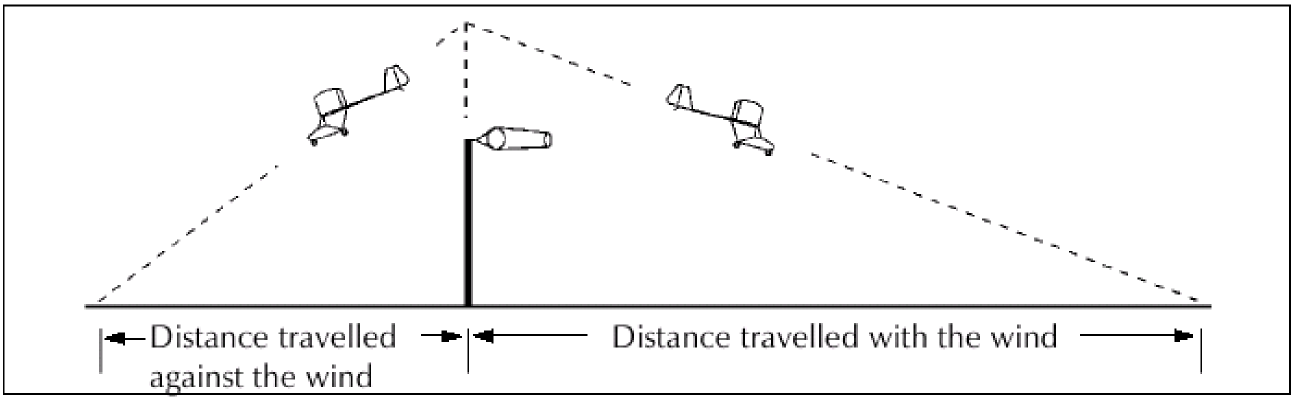

Fig. 47 Effect of wind on angle of glide relative to the ground.

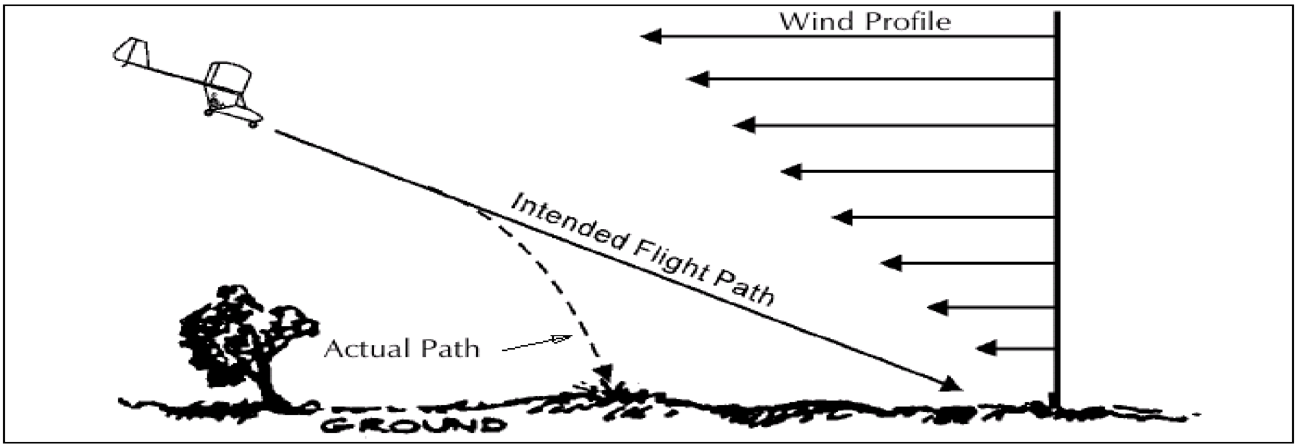

Fig. 48 Stalls due to wind gradient.

FORCED LANDING WITHOUT POWER

The pilot must bear in mind the fact that an engine failure could occur at any time, and this demands preparedness. One of the basic safety rules already mentioned is to ensure that there is a good landing area always within easy gliding distance, even if this seems a detour must be made. Another rule is that, having plenty of height when the engine fails gives the pilot a better choice of landing field within gliding distance, and more time to plan a descent and possibly rectify the engine failure.

Flying over rugged terrain is asking for trouble! If the engine should fail, adopt the following course of action immediately which should be memorised thoroughly:

- 1 Assume the gliding attitude and airspeed and close the throttle.
- 2 Check the wind direction and strength.
- 3 Choose a suitable field for landing.
- 4 Plan descent.
- 5 Check fuel, choke and ignition.
- 6 Brief passenger.
- 7 Mayday call if applicable.

1. Assume the gliding attitude and airspeed: Once the engine has failed you are now flying a glider so lower the nose to the best glide angle airspeed.

2. Check wind direction and strength: The pilot should always have an idea of the wind direction and strength, but double check it with observation of:

- smoke or dust drift.
- wind lanes in crops or on water.
- tree movements.
- movement of cloud shadows on the ground (reflects wind strength and direction at cloud base).
- flags or windsocks (you should be so lucky!).

3. Choose suitable field: Pick a field that is within easy gliding distance, preferably enabling you to arrive overhead with enough height for a glide approach. The field should be as long as possible, into wind to reduce touchdown speed and with good obstruction free approaches. It should also have a reasonable surface and be free from obstacles and be flat or slightly uphill.

4. Plan Descent: With the field selected, an approach has to be planned to carry out a successful landing. If there is sufficient height, plan to arrive abeam the threshold at 500ft AGL (as in glide approaches).
5. Check fuel, choke and ignition: If there is sufficient height and time, check fuel sufficient, cock turned on, choke off (mixture correct), ignition on. Check for partial power the engine may lose power but not necessarily stop, in which case any partial power may assist the landing, but should not be relied upon.
6. Brief passenger: If you are flying a two place with a passenger, he or she will be greatly reassured by your brief explanation of your intentions. Point out your intended landing field and calmly show them the location of any emergency equipment (first aid kit etc) on board. Make sure helmets and straps are secure. A little reassurance goes a long way in a situation like this.
7. Mayday Call: If radio equipped and time still permits, make the standard Mayday call .
Continue with approach. Don't forget the downwind checks and select fuel and ignition off, throttle closed on final.

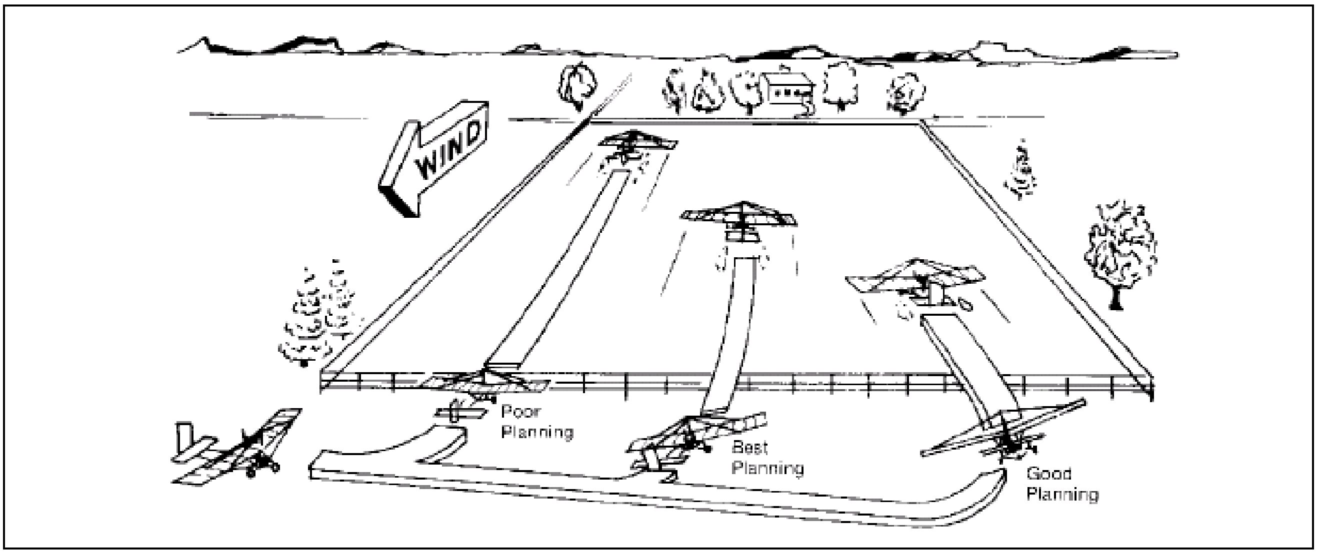

Fig. 49 Forced landing into wind to touchdown in first half of field.

Remember:

- Avoid steep turns.
- If you are too high execute gentle "S" turns to lose height while approaching the field. Do not try a quick 360° turn as you will lose more height than you think.
- Stay near your chosen field and keep it in view at all times.
- Keep the landing field at an angle of 45° to you at all times, this will assist you not becoming too low.
- Try to note the distance and direction to the nearest dwellings.
- Don't let a restart attempt or Mayday call distract from approach judgement.

"Do not get airborne again until the engine problem has been correctly and carefully rectified."
Once safely down, secure the aircraft and if possible, notify the appropriate people of your whereabouts and situation.

PRECAUTIONARY LANDINGS

This is simply an unplanned landing carried out for safety reasons. There are many situations where a precautionary landing is called for. A problem with the microlight, deteriorating weather, or becoming lost are some examples. The aim of a precautionary landing is to terminate a flight safely before a dangerous situation arises or gets out of hand. No pilot should feel compelled under any circumstances to continue with a flight if safety is going to be compromised and a safe landing can be made. For whatever reason it is decided to terminate the flight, the next course of action is to select a suitable landing field.
Depending on the situation the choice of field may vary, but look for the largest, flattest, smoothest field around with good approaches into wind.
Before approaching to land at your selected field, it should be closely inspected from the air first.
Descend to 500ft and circle the field looking closely for suitable surface, slope, wind orientation, length and obstacle free approaches. Note any features upwind which might cause mechanical turbulence and look particularly carefully for wires across the field and on the approaches.
Assuming all looks well from 500ft, plan your approach and carry out an approach with an overshoot, so as to check the field and approach more closely. This should be done by flying to the right of the centre-line of the landing field to inspect the left hand side (where you intend to land). If this shows everything to be satisfactory then commence the circuit from the overshoot and land.

It takes an experienced eye to pick a good field from the air. Slope is very difficult to ascertain, particularly if the field lies in a valley where the surrounding hills give a false horizon. Also, when the sun is high in the sky, undulating paddocks can sometimes appear flat, and with a low sun they can sometimes look more rough than they really are.

Don't forget to note the distance and direction to the nearest dwelling before landing.

After landing, secure the microlight against wind and stock damage, then notify the landowner and other appropriate persons of your situation and your intentions.

As mentioned above, picking good fields from the air is not always easy, but by making a habit of observing and evaluating potential fields at every opportunity, when the day comes for a real precautionary landing, the event will be that much easier.

CROSSWIND OPERATIONS

Microlights are very prone to being affected by a crosswind because they are very light. When taking off or landing with a wind from the side, there is a tendency to weathercock (turn into wind) as the wind acts on the rudder surface. The extent of this tendency depends on the undercarriage position relative to the centre of gravity and the centre of pressure, and the strength of the side wind component.

Also to be considered is the effect of the dihedral angle of the wings in a crosswind. Microlights with a pronounced dihedral may tend to have the upwind wing lifted as the wind gets beneath it. It is these factors which makes keeping the microlight moving in a straight line on the ground in a crosswind difficult, and requires care by the pilot. To some extent the turning moment can be counteracted by use of roll control (aileron), in applying an opposing downward force on the upwind wing by holding the controls into wind. The ability to control the microlight in a straight line is to a large extent dependent on the effectiveness of the rudder in counteracting the weather cocking tendency.

Crosswind Takeoff

Hold full roll control into wind and use the rudder to keep the microlight straight as the take off begins. As flying speed is near ease off the into wind control as effectiveness increases. A slightly higher than normal liftoff speed is desirable. The slightly higher liftoff speed assures a positive rate of climb initially to preclude any chance of touching down again; since to touch down while crabbing to offset the drift would almost certainly damage the microlight. So once airborne, offset the drift to track straight down the runway.

Crosswind Landing

On the approach crab so as to track down the extended centre line of the runway, a slightly higher than normal approach speed may help with control of the microlight in windy conditions. When rounding out the microlight must be straightened with the rudder so as to face directly down the runway.

There are two methods of counteracting drift:

- The nose of the aircraft can be turned in the opposite direction to the drift, so that its fore aft axis is at an angle to the flight path.
- A sideslip can be made towards the wind which will cancel or balance the drift.

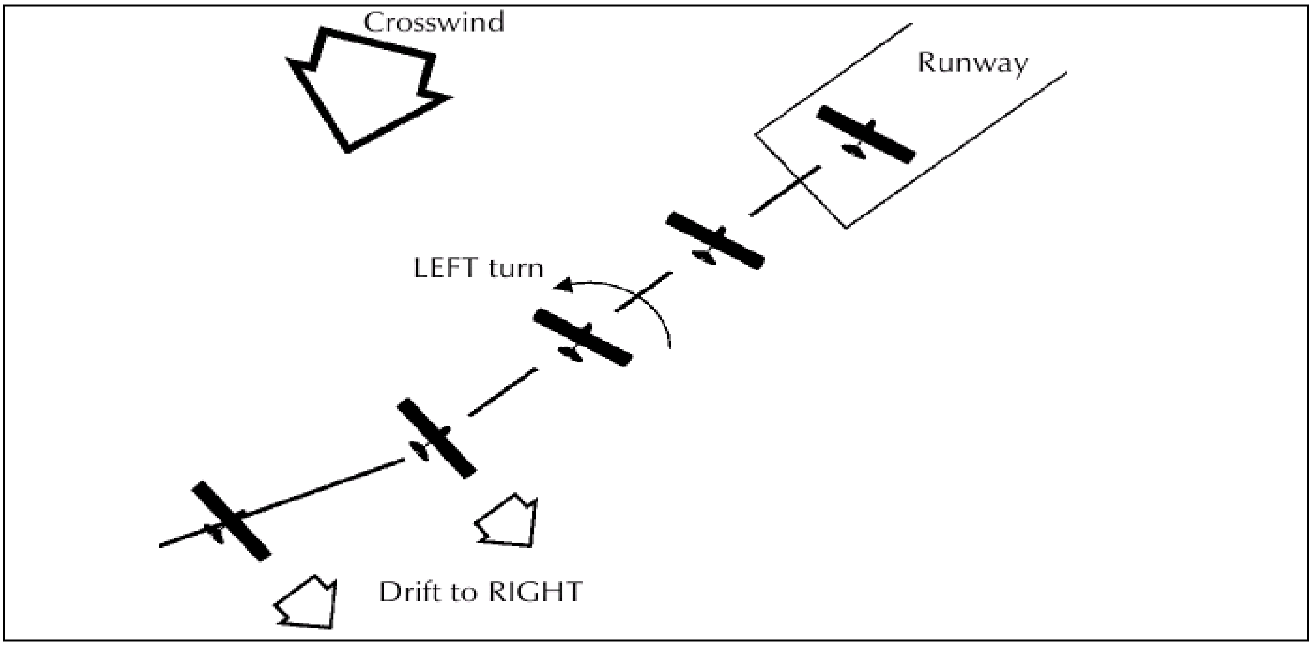

Fig. 50 Drift is counteracted by turning the nose of the aircraft towards the wind.

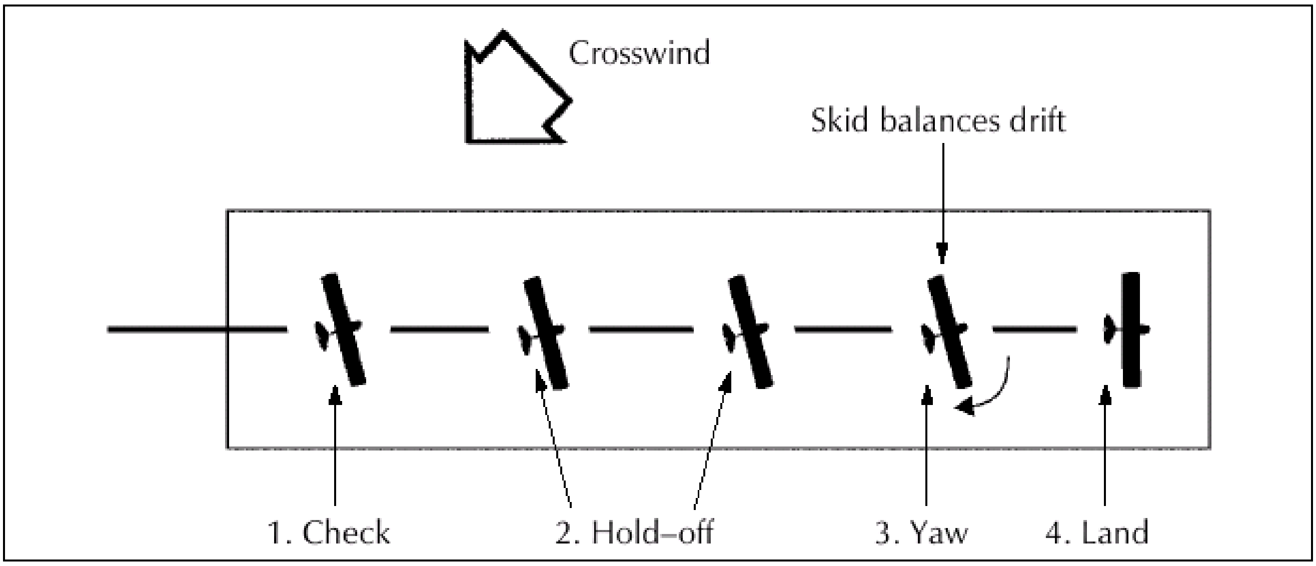

Fig. 51 The final stages of a crosswind landing (method 1). Lining up with the runway causes a skid which balances drift.

"The microlight must not be landed while travelling sideways across the ground."
If the aircraft does begin to drift sideways the upwind wing should be lowered, preventing the yaw with the rudder. The microlight is flared and lands on the upwind wheel first, and after touchdown holds full roll control into wind. It is once on the ground that the fun can really begin.
As the aircraft slows and control effectiveness reduces, the crosswind will try to weathercock it into wind, lift the upwind wing, or both. The pilot must be ready to use full controls to counter these tendencies. Each type of microlight behaves differently and can cope with varying degrees of crosswind, so consult your owner's manual and get expert advice.

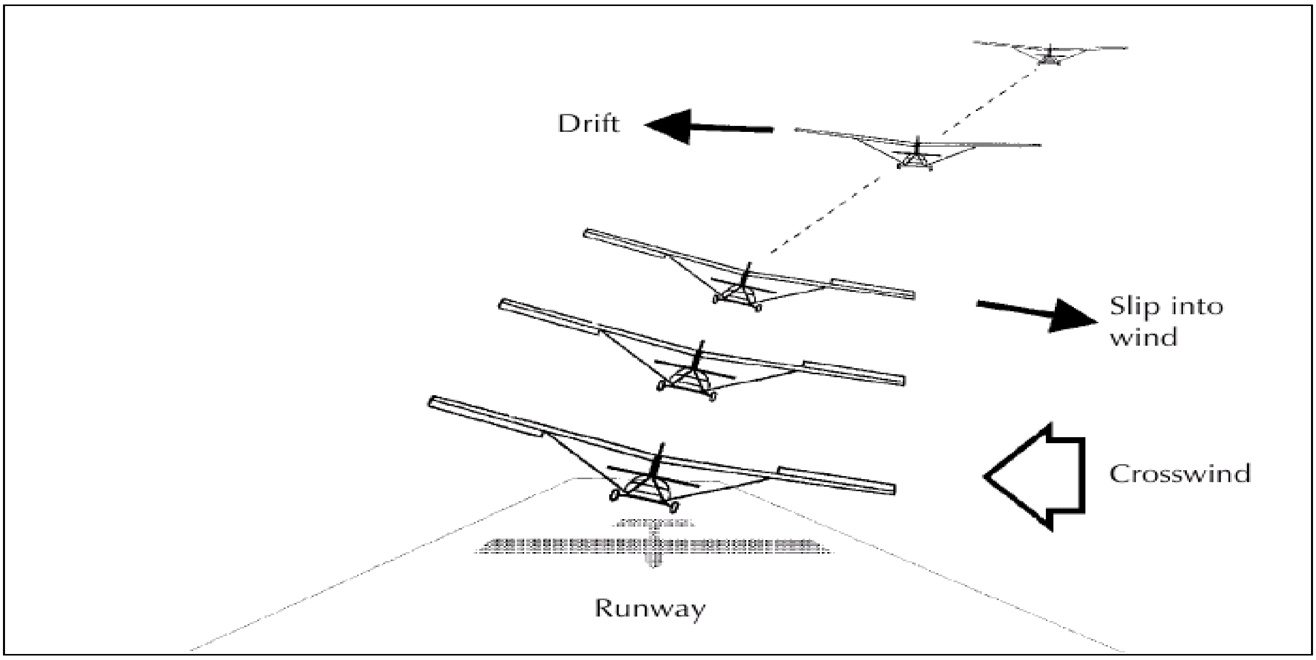

Fig. 52 Crosswind landing (method 2). A sideslip is used to counter drift.

SIDESLIPPING

This is a method of increasing drag which is normally used on final approach as a way to reduce height. This can be achieved by cross controlling the aileron and rudder, (i.e. left aileron and right rudder) and adjusted as required to maintain the centre line of the runway. The maximum effect being achieved when either, or both controls are fully deflected. Care must be taken to resume normal (balanced) flight prior to landing. In some aircraft the effect of this manoeuvre can be quite dramatic as there can be a very large increase in the rate of descent.

LOW FLYING

MCAR Part 91 states that flight should be at least 500ft AGL except when on the extended centre line of the runway taking off or landing. Therefore low flying should only occur during training or in marginal weather as an operational requirement. When at low altitude, the sensation of speed is greatly increased. Care will have to be taken to anticipate the time and distance required for turns. This is especially so when there is any wind present. The ground track of a turn made out of wind will be much wider than a turn into wind and a climb with a tail wind will reduce the climb angle. Also a turn downwind will need an increased airspeed.
Aspects like these are mentioned in the flying in wind section, but we point them out because at low altitude their importance is magnified. Collision with an obstacle or the ground is only a miscalculation away. Grim as it may sound, it is essentially true.
Flying near the ground requires considerably more accurate flying skills than at altitude. A low altitude stall for example could be disastrous as there may be insufficient height to recover. It is possible to fly in to an area which is too restricted to turn out of or climb out of. Naturally, mechanical turbulence at low altitude will be violent and make control difficult.
When low flying, keep in mind the following:

- Maintain proper airspeed and make balanced turns at all times.
- Anticipate! Keep your thinking well ahead of the aircraft, anticipate all manoeuvres with regard to effect of wind, turbulence, room needed etc.
- Do not forget to monitor engine and fuel supply. Bear in mind that map reading will be difficult due to the smaller field of view.
- Choices of emergency landing fields will be extremely restricted should the engine stop.
- Lookout! When low flying, one's attention should be largely outside the cockpit, looking ahead carefully, anticipating what is required. Below 500ft AGL there is a real possibility of flying into a wire of some sort. The possibility of encountering other aircraft at that height is also there after all, if you have been forced to fly low by weather, then so will any other pilot in the vicinity.

Operating at low altitude requires total concentration for safety. Low flying in bad weather in unfamiliar country with turbulence while trying to map read is best avoided if at al possible!

Landing & Taking-off on Hill strips

Mongolia, because of its terrain has many sloping airfields, many of them agricultural strips.
The golden rule is to land up hill and takeoff down hill regardless of a possible downwind component (providing flying conditions are suitable). Beware of turbulence.

- Landing: When making an approach to a sloping (rising) airstrip, extra speed is required on the approach to effect a round-out, and then "fly up" the strip before the wheels touchdown. If you are landing into wind, uphill, beware of rotor turbulence.
- Taking-off: Takeoff downhill as most aircraft will be unable to out climb the rising ground, irrespective of wind direction. Generally, the steeper the slope the greater the downwind component can be, for a downhill takeoff.

WIRE STRIKE

Because of the nature of microlight operations, where paddock landings and farm airstrip operations are common, the possibility of flying into wires is relatively high. No pilot can afford to be complacent about wire-strikes.
Firstly it must be stated that as far as the Ministry of Transport is aware there are no wires anywhere above 500ft above ground level (AGL) in Mongolia.
The first defence against wire-strikes therefore is to avoid unnecessarily flying below 500ft AGL. It is the takeoff and landing where a wire-strike is most likely.
Can't we see the wires? Yes, but only under ideal conditions. In fact, the odds of actually sighting the usual country power line or telephone wire from a safe distance (in flying terms) while airborne, are small. Against a plain contrasting background such as the sky, the wire is more likely to be seen.
The second defence against wire-strikes is to be aware of wires, to think wires. What is needed is an active awareness of the possibility of wires at low altitude. If the wire itself is difficult to see then the pole or pylon supporting it may be easier to spot. Electric fence wires strung across valleys and paddocks by farmers are probably the most difficult to see especially as the supporting pole may be small or even a tree or shed.
Ask the property owner and other pilots about any wires in the area and keep in mind that wires do literally appear overnight!
Inspect any prospective landing field very carefully for wires on the approach and overshoot either by visiting first on foot or with extreme care from a safe height when airborne. During the airborne reconnaissance, use circling manoeuvres as these will vary the light conditions and reflections and thus increase the chances of detecting wires or their supports. Finally make a lower level reconnaissance if possible, which may enable you to detect some wires that were not visible when viewed against the background of mother earth.

If in doubt, fly above the height of the supporting poles or pylons. Remember that there may be an earth wire running above the power wires.
Cross lines at an angle, and over, or at least near the pylons. The angled crossing gives an easy turn away if the height of the wires has been misjudged. If you can see high tension transmission lines, beware of the earth wire that is often strung above them. Again, above pylon height will keep you above trouble.
Don't attempt to "just miss" wires, but give them a wide berth. Judgement of distance can be very difficult.
If you have to takeoff or land over wires, your main defence is a thorough understanding of the performance and capabilities of both your aircraft and yourself. Microlight pilots, in particular, need this skill for out landings.
Electric fences used by farmers for grazing control can be extremely hard to spot. While some types of wire and standards used are brightly coloured they can still be virtually invisible to the pilot until very near.
Probably the easiest indication of the possible presence of an electric fence are variations in the colour of the surface of the paddock as it is grazed down. From the air this is readily apparent, but of course, only after stock have been grazing for some time.
Beware of support wires for aerials which can be anchored quite some distance from the structure itself.

CLOUD FLYING

Illegal? You Bet!!! In flight we rely primarily on our sight to tel us which way in relation to the ground we are orientated. Take away our visual reference to the ground and even our balance sensing inner ear mechanism is of no use whatsoever.
In an aircraft with three dimensional movement, without the help of visual contact with the ground, our brain gives us completely false sensations of "which way is up" (known as vertigo).
The microlight pilot who flies into cloud is suddenly enveloped in a damp, grey, featureless environment, and visual contact with the ground is lost. In a very short time (seconds) the pilot will be misinformed by his senses as to which way is up, and will move the controls according to this false impression, leading to erratic and uncontrolled flight. This could easily lead to overstressing of the airframe.
No matter how good you think your sense of balance may be, nor how experienced a pilot you are, the reality of vertigo is that you WILL suffer from it. Even pilots of suitably equipped larger aircraft in instrument conditions sometimes feel quite sure their instruments are wrong. Their senses tell them one thing, while the instruments, functioning perfectly, tell the undisputed truth.
Don't kid yourself that your microlights' inherent stability will keep things on an even keel until you emerge from the cloud. The interior of some clouds is violently turbulent with rain, hail, airframe icing and lightening.
Sometimes, when flying in reduced visibility, such as too close to cloud base or in light fog or rain, it is possible to see quite clearly downwards, while forward vision is badly obscured. The dangers here are obvious, and pilots should remember to judge their visibility with this in mind. See Aviation Law section for microlight visibility requirements.

NIGHT FLIGHT

Night flying in microlights is also illegal of course, with obvious vertigo and navigation problems.
While no pilot hopefully would be fool enough to contemplate a night flight, there may be, on occasions, times when a flight has been badly misjudged and landing takes place near darkness.
The hours of morning and evening civil twilight are in tables in the A.I.P. planning manual. One of the problems of landing in partial darkness is that depth perception suffers, making it difficult to judge the last phase of the landing.
Remember that an overcast sky can effectively bring forward the onset of darkness quite considerably.
The hours of darkness are from after Evening Civil Twilight (ECT) to Morning Civil Twilight (MCT). These are published in the Visual Flight Guide (VFG).

3. Technical

MICROLIGHT AIRCRAFT OWNERSHIP

Unlike conventional aircraft with their established maintenance schedules and regular inspections by aircraft engineers, microlights in Mongolia rely largely on the owner/operator to take responsibility for maintaining the aircraft's airworthiness, detecting faults and organising correct repair. It is a responsibility not to be taken lightly, but one which the owner/operator can easily manage by ensuring a regular and thorough inspection of the aircraft is made. This is in addition to the normal preflight inspection which the pilot in command is responsible for.

It should be assumed at every inspection that deterioration has taken place. Only by constant vigilance can structural failures be checked. Remember that by nature of their every design, virtually every component of the microlight is vital to the overall airworthiness.

Every Class 2 (2 seat) microlight must have a valid "Permit to Fly" before it can be flown. All microlights must also have a current annual inspection. Microlight Inspection Authority people are available for this- contact your local club.

Once the owner/pilot has completed his or her training and gradually leaves the watchful eye of the instructor, there may be a tendency for flying standards to lower. Here again it is the pilot's responsibility to ensure flying skills are maintained. Remember that instructors are available to help.

Indeed skills should continue to grow with experience, and pilots are encouraged to seek qualified advice if ever they feel they need it, in the interests of safety and increased enjoyment of the sport.

WEIGHT AND BALANCE

All aircraft are designed to operate within certain load and balance conditions. It is the pilot's responsibility to make sure that the microlight is not overloaded and is within its centre of gravity limits.

When loading an aircraft there are three kinds of weight we must consider:

- Empty Weight this is the weight of the basic microlight, the airframe, engine all fixed instruments and equipment, unusable fuel supply, un drainable oil (if any).
- Useful Load or Payload this is the weight of pilot, passengers, useable fuel supply, baggage and drainable engine oil (if any).
- Gross Weight (M.A.U.W.) this is the empty weight plus the useful load, giving us the gross weight at takeoff.

When the machine is loaded to the maximum weight stated in the manufacturers manual, the machine is at Maximum All Up Weight (M.A.U.W.).

This is also referred to as Maximum Takeoff Weight (M.T.O.W.).

The manufacturer will normally state in the owner's manual (it's a good idea to placard it in the microlight) the maximum and minimum weight of pilot and passengers. Remember a person's weight includes the weight of clothing and items carried. What happens if we exceed the weight limits advised?

OVERLOADING

Overloading a microlight will severely reduce the aircraft's performance! It will result in:

- A higher takeoff speed.
- Longer ground run.
- Reduced rate of climb.
- Reduced angle of climb.
- Shorter range.
- Reduced cruise speed.
- Increased stall speed.
- Increased sink rate.
- Higher landing speed.
- Longer landing roll.
- Lower maximum ceiling.
- Decreased g loading capability.

Take another look at list. If you overload aircraft you will not suffer from just one of the above, but ALL of the above!

An aircraft with 3.8g design load factor at MAUW, flown with a 25% overload, has its capability reduced to about 3.0g.

Balance

Further to the issue of loading your microlight there is the equally vital question of whether or not the aircraft is balanced correctly.

Centre of Gravity

This is the term used to describe the point about which an aircraft would balance if suspended.
If the aircraft is loaded so that the centre of gravity is within the fore and aft limits prescribed by the manufacturer, then the aircraft will handle and function normally (assuming it is not overloaded!).
Few microlight manufacturers provide aircraft type loading graphs to help determine the centre of gravity for whatever load it is intended to carry. However, they will normally indicate minimum and maximum pilot/passenger/baggage weights and keeping within these limits assures a correctly balanced aircraft. Consult your owner's manual and study any information therein related to the weight and balance of your aircraft.
Loads forward of the centre of gravity "C of G" (which is usually about 1/3 mean chord) impose a nose down force, and loads aft of the centre of gravity impose a tail down force. Loads at the centre of gravity do not alter the C of G.
The further the distance from the C of G a load is placed, the greater the effect on the balance will be. When the loads ahead and aft of the C of G are proportioned correctly, the aircraft will be balanced for flight.

Effect of Aft C of G

With an aft C of G (too much weight behind the desired C of G) generally an aircraft becomes more pitch unstable and often stall characteristics become more violent. Extra nose down control input will be needed to prevent the aircraft pitching up into a stall. On takeoff the aircraft might develop a high nose attitude which may be difficult or impossible to correct. Only very light control forces will be needed to pitch the nose up, and in this condition the aircraft may easily be overstressed.

Effect of Forward C of G

With the aircraft loaded with a forward C of G (too much weight ahead of the desired C of G) extra nose up control input will be needed to prevent the aircraft pitching down. There may be insufficient nose up control available to rotate for lift-off and for flaring for landing. Dive recovery will be impaired.
Both the previous conditions cause pilot fatigue as the unusual loads required on the controls may be more than the aircraft's trim systems can relieve (assuming it has one). Weight and balance must be taken seriously.
"A Microlights behaviour in the air is dependent on weight and balance"

THE PROPELLER

The job of the propeller is to convert engine power into forward thrust. The propeller is made to rotate by the engine, and in doing so develops lift at approximately right angles to the plane of rotation. This produces a backward stream of air called the slipstream, which is the thrust.

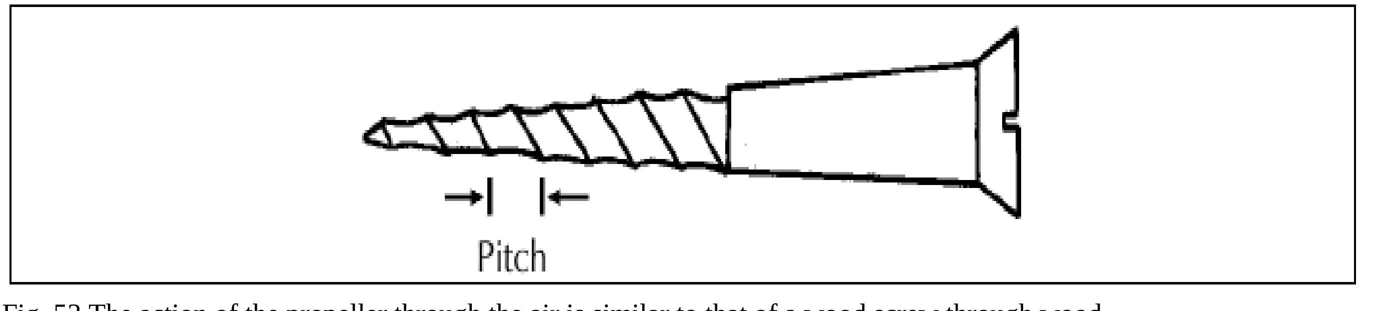

Fig. 53 The action of the propeller through the air is similar to that of a wood screw through wood.
The aerofoil section of each propeller blade is set at an angle to the plane of rotation, this is called the Pitch.

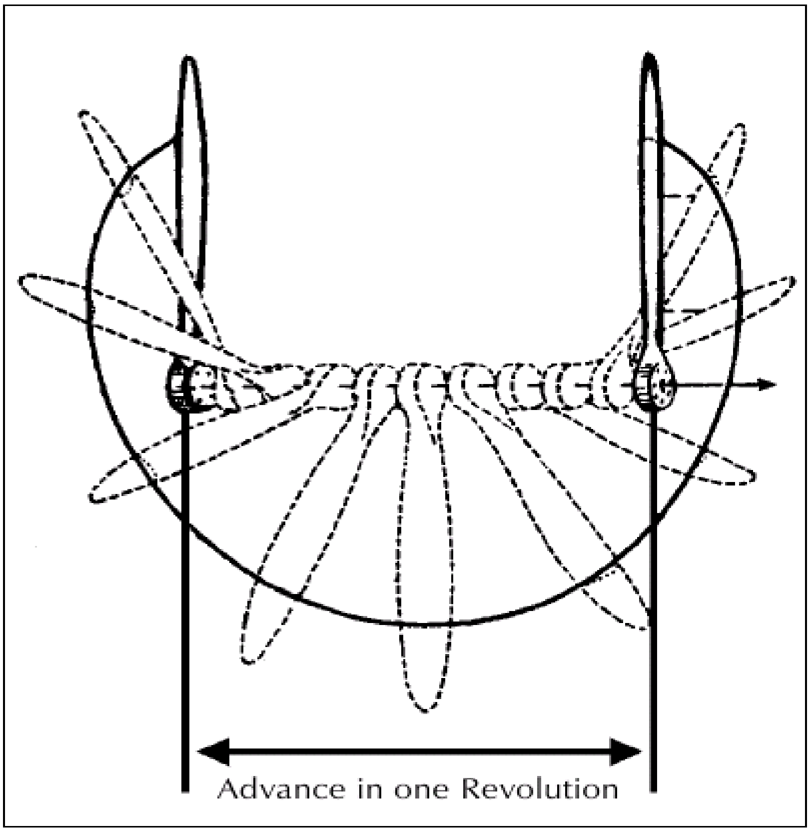

Fig. 54 Because the tips of the propeller travel very much faster than near the hub, the pitch is at its maximum at the hub and progressively reduces towards the tips.

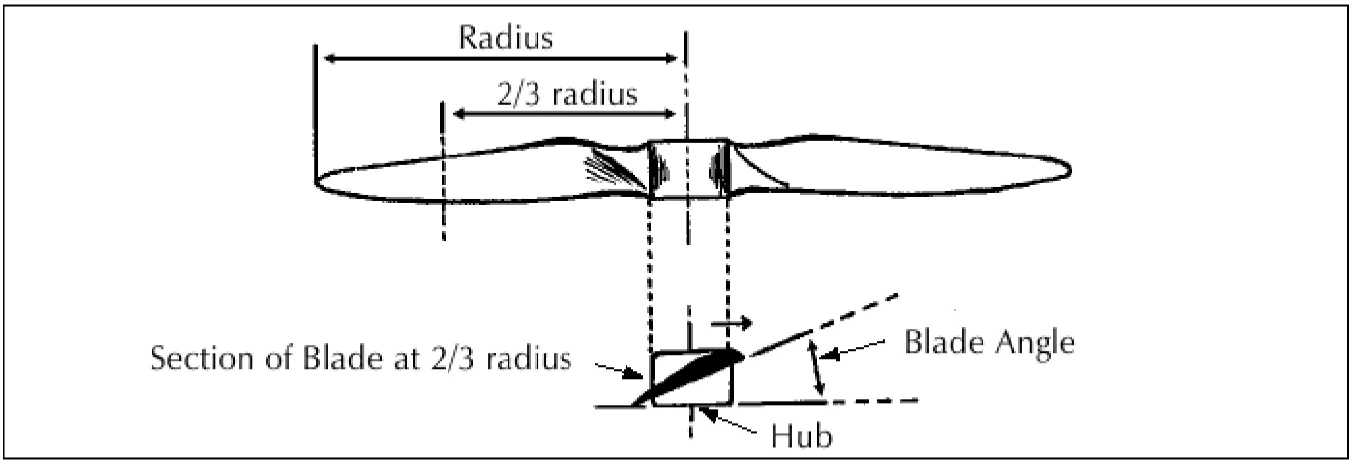

Fig. 55 Propeller theory is complicated by the fact that the propeller blade angle relative to the airflow changes with forward speed and R.P.M., being at its maximum while the aircraft is at rest at high R.P.M., reduces to a minimum during flight at maximum speed, and assumes a negative angle in a steep dive at low R.P.M. In this respect the fixed pitch prop will only be at its most efficient at the revolutions and forward speed intended by its designer.

This last point highlights the dilemma of the fixed pitch propeller. A fixed pitch propeller can be designed to be most efficient at only one task, e.g. a fast cruise speed. While it may excel at one task, it may be fairly unsuited to another. For this reason most fixed pitch propellers are designed as somewhat of a compromise to provide adequate performance for each task, although probably favouring one goal.
Two such propellers are the Cruise and Climb propellers. A propeller designer wishing to produce a propeller that will afford a fast cruise speed will create a coarse pitch design. The coarse pitch refers to a larger blade angle which will produce good thrust at lower R.P.M. and at a greater forward speed. However, this propeller will result in an extended takeoff run and reduced climb performance.

Cruise propeller	Advantages	Disadvantages
Coarse pitch	Good cruise speed	Long takeoff roll
		Poor climb performance
Climb propeller	Advantages	Disadvantages
Fine pitch	Good takeoff run	Low cruise speed
	Good climb performance	

A propeller designed to give a short takeoff and good climb capability will be of a fine pitch design. The fine pitch refers to a lesser blade angle, which will produce good thrust at high R.P.M. (takeoff power) and low forward speed. Thus an aircraft with a fine pitch prop will accelerate quickly, takeoff with a shorter ground run and climb well . Unfortunately the cruise speed will not be as good as with a cruise prop.

Propellers are described in terms of their diameter and pitch. For example a 54x27 inch prop is a propeller 54 inches in diameter, and with a theoretical pitch giving 27 inches of forward movement per prop revolution.

The long distance flyer will probably choose a cruise prop for his/her aircraft, while the pilot who does not fly far, but sometimes operates from smaller fields, would require a climb propeller.

Of course, a variable pitch prop, adjustable in the air, would provide the best possible solution, enabling the use of fine pitch for takeoff and climb and then coarse pitch for cruise. Unfortunately such propellers are not commonly in use on microlights and are sure to be expensive and significantly heavier.

There are available however, ground adjustable units. The idea here is that the pilot can select and set up the desired pitch before takeoff according to the task at hand.

Propeller Care

When you start the engine and the propeller becomes a blur, it is easy to overlook the incredible forces it is coping with during the course of its work. As it spins centrifugal force tries to rip each blade out of the hub. At the same time there are various twisting and bending forces associated with the production of thrust. At high R.P.M. in particular the propeller is under enormous strain.

When we consider that the propeller is also acting as a flywheel, it is plain that it must be perfectly balanced in order to spin smoothly without vibration. With the high tip speeds any imbalance will cause serious vibration. Furthermore like any lifting surface it must be aerodynamically balanced to operate smoothly.

Microlight propellers seem to suffer from more than their fair share of woes. They are mainly constructed from carbon fibre or from laminated wood and although this material is well suited to the task, the prop needs a fair amount of care during its life.

A propeller's (especially wooden) biggest enemies are the likes of water, stones, sticks, thistle stalks, cow pats, sheep manure and mother earth.

The outer third leading edge of each blade is the most subject to damage from these things, and normally this section is given some sort of protection in the form of a plastic tape, fibreglass coating, metal cap or other. These devices are intended to help reduce impact damage (small objects only) and abrasion to the leading edge. Flying in rain, a wooden prop without leading edge protection can be badly damaged as the raindrops blast through the varnish and begin tearing at the wood fibres, thus in a short time the leading edge may be ruined.

Obviously, a stone or other hard object striking the prop will really do some damage. Stones and gravel usually find their way into the prop disk by being sucked up off the ground by the propeller if it is near enough, or by being thrown up by the wheels. It pays to assess an airfield's surface carefully, even pace it out, to check for anything likely to cause propeller damage. That discarded piece of fencing wire lurking in the grass could spoil your day.

The propeller itself deserves special attention during the preflight. Inspect both faces of each blade and each edge, looking for nicks, worn spots, cracks. Wipe the prop clean if needed. Check the security of any leading edge protector. A piece of propeller tape for example, missing or peeling off, could produce vibration bad enough in flight to necessitate the immediate shut down of the engine! Watch for play around the propeller hub mounting. Any damage should be considered serious and replaced or repaired by someone qualified.

If vibration occurs in flight suspect propeller trouble, reduce power if possible and land. In the event of severe vibration shut the engine off immediately. Treat all propellers as live and never allow people near your aircraft while the engine is running.

Reduction Drives

The use of small two-stroke engines in microlights has necessitated the use of reduction drive because these engines develop their power at R.P.M. far in excess of suitable propeller R.P.M.
To give an example, a small propeller of say 48 inches diameter would have a tip speed of 785 M.P.H. (685 kts) when driven at 5500 R.P.M. assuming the engine could develop sufficient power. Much of this power would be wasted shock waves as the propeller exceeded the speed of sound across the outer areas of the blade. Therefore, some sort of reduction is needed to match ideal propeller speeds with the best engine efficiency R.P.M.
These can take the form of:

- Chain drive.
- Toothed belt drive.
- Multiple V belt drive.
- Gearbox.

The most commonly used reduction method utilises a gearbox with a reduction of approximately 2.5 to 1, i.e. the engine runs at two and a half times the propeller R.P.M. Gearboxes require the oil to be checked regularly.
If a belt reduction is used the belts must be checked during preflight for correct tension and wear.
The correct tension is maintained with an adjusting device. Slipping belts result in a loss of power to the propeller, and rapid and destructive wear to the belts. A good feature of belt drives is their ability to absorb engine and prop vibrations. Accurate alignment of pulleys is important.

PISTON ENGINES

The microlight engine produces power by converting petrol into heat and energy. The energy is collected by mechanical means and the resultant power is transmitted by a rotating shaft which is linked to a propeller in the aeroplane. It is self evident that when ignited a liquid fuel will burn and produce heat but how the heat is able to provide mechanical energy will be less obvious until it is realised that heat can be applied to air. When heated, air will expand considerably, exerting great pressures if contained in any way.

Method

To provide perfect combustion in the engine, petrol and air must be mixed in a ratio of approximately fifteen parts of air to one part of petrol by weight. Too much petrol causes a "rich" mixture (which may be recognised by black exhaust smoke). This is both wasteful of fuel and damaging to the engine because heavy carbon deposits build up in the combustion areas.
Conversely, too little petrol in relation to air causes a "weak" mixture. This too, is damaging to the engine, for instead of the mixture burning at an even rate on ignition, an explosion occurs causing severe strain on the engine accompanied by overheating and loss of power. In most piston engines fuel is mixed with air in the "carburettor".

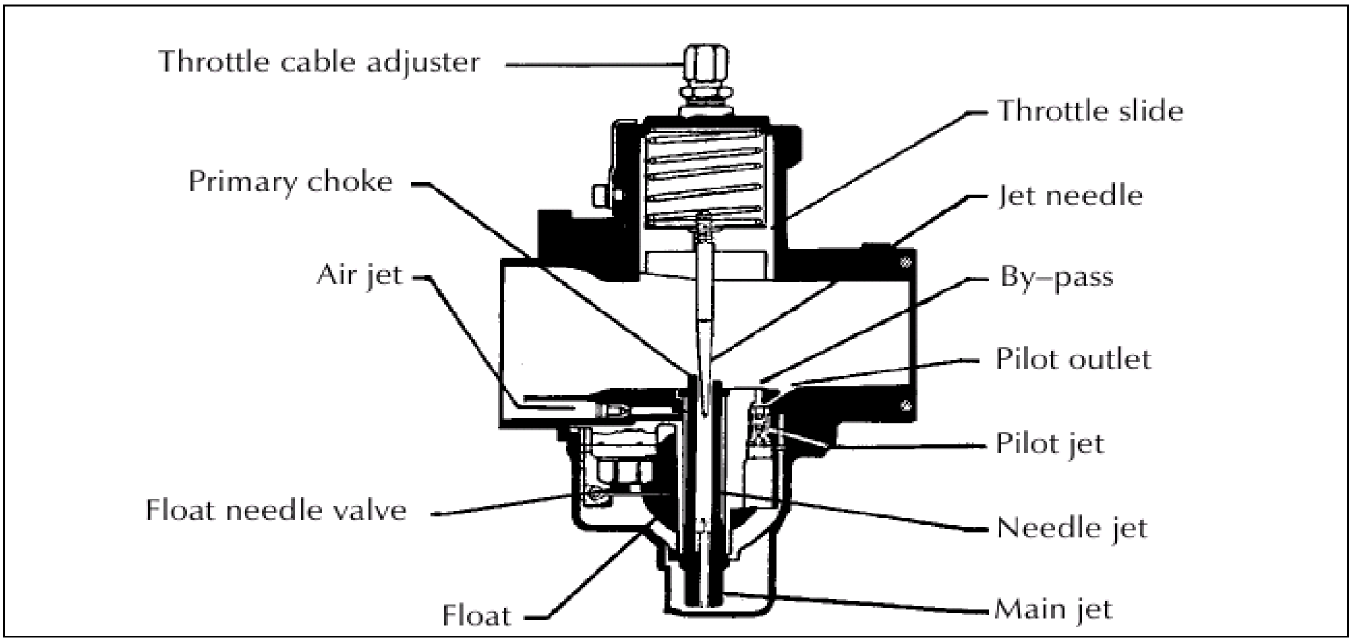

Fig. 56 Cross Section of a float carburettor.

Fuel from the aircraft tanks is pumped to the carburettor and enters a device similar in design to a domestic toilet cistern called a "float chamber", its function being to maintain the fuel at the correct level in the "jets". These jets create an atomising action rather similar to that of the nozzle of a scent spray. It is usual to provide a "slow running jet" for the purpose of engine idling and a "main jet" for normal operation. On some carburettors when the throttle is opened for maximum power an additional "power jet" is brought into operation.
A reduction in air density will occur as the aircraft gains altitude and since this would result in an over rich fuel/air mixture, the carburettor may be provided with a "mixture control". A throttle slide is positioned between the jets and the engine and linked to the pilot's throttle control so that the amount of mixture entering the engine may be regulated, this in turn determines the power output to the propeller.
The carburettor just described is typical of the type used in many microlights powered by simple two-stroke engines. Some microlight motors are fitted with a diaphragm carburettor (instead of a float chamber type). The advantage of these carburettors is that they are not affected by operating in any attitude.
The tuning of any carburettor is important and should be done in accordance with your particular engine manual. For two-strokes, because they can generate large amounts of heat quickly, correct tuning is critical. A useful check for correct tuning is to examine the spark plugs after a full power run, they should look a light tan in colour. If they are blackish then your engine is too rich. If they are whitish then your engine is too lean.
For engines with dual carburettors it is important that the throttle slides are set the same throughout the throttle range. The jetting and float levels must also be the same.

Provision of Rotary Motion

In a bicycle the reciprocating motion of the rider's legs is transmitted to the crank via a pair of pedals so converting an up and down motion into a rotation which is transmitted by a chain to the rear wheel.
In a piston engine the crank and pedals are replaced by a "crankshaft" and the "legs" of the engine are provided by a "connecting rod" which links the crankshaft to the piston (the muscles of the leg). To allow for the sweeping motion of the crankshaft as it rotates within its "crankcase" provision is made for the connecting rod to pivot on a "gudgeon pin" inserted across the piston axis which passes through the "small end" of the connecting rod and the "crank pin" (equivalent to the pedals on a bicycle) is free to rotate in the connecting rod "big end bearing".

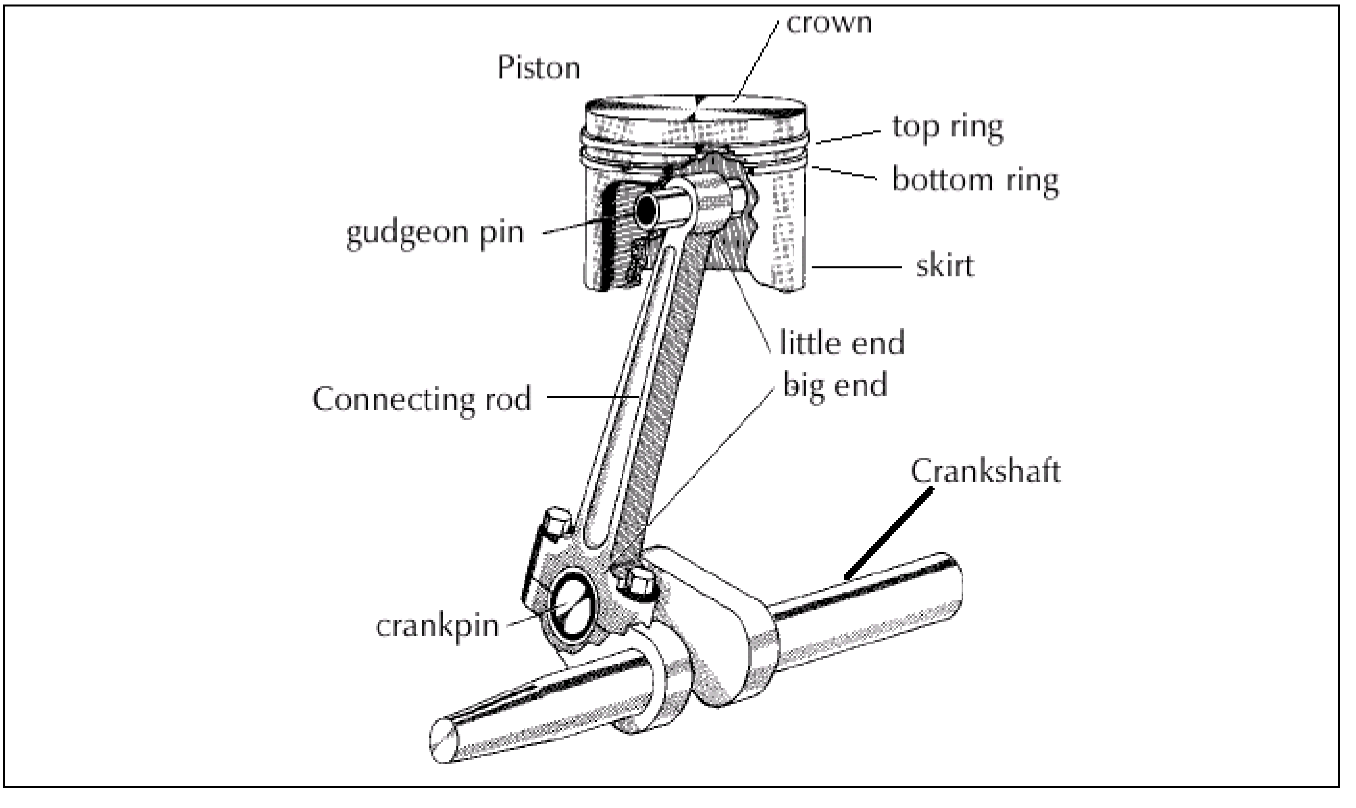

Fig. 57

When the engine is running at 3000 R.P.M. the piston and connecting rod must go up the cylinder, stop, descend down the cylinder and stop again (ready for the next ascent), fifty times every second, and it is usual practise to counterbalance the crankshaft so that vibration is kept to a minimum.

Cooling

Quite apart from the heat generated by fast moving parts is the very considerable heat resulting from combustion in the mixture. When running at 3000 R.P.M. an engine such as the single cylinder unit under discussion would ignite every revolution or at 3000 R.P.M., 50 times per second. When there is a need to burn more fuel to provide extra power (e.g. during a climb) the engine temperature increases. Unless the surplus heat generated were dissipated in some way it would only be a matter of minutes before the cylinder head became excessively hot and the engine seized. In a car the problem is solved by surrounding the cylinder and cylinder head with a series of passages cast in the cylinder block. Water is pumped through these passages (water jacket) and returned through a radiator to disperse the heat by the air flowing through it.

While liquid cooling has in the past been adopted for some very successful high performance aero engines (notably the Rolls Royce Merlin) large engines are now practically confined to the gas turbine family. Lower power aero engines have almost without exception always relied upon a cooling system which dispenses with the radiator and its tank, the water jacket around the cylinder and the coolant itself. This simpler and lighter method, in fact the one used on motor cycles and small petrol mowers, is called "air cooling". Fins are machined around the outside of the cylinder barrel and cylinder head and a system of sheet metal baffles guides the airflow through the engine cowling and around the fins, carrying away the excess heat through the rear of the engine bay.

Liquid cooling is now more common in microlights, due to technological advances. Unfortunately some two thirds of the fuel energy in an internal combustion engine is wasted, only the remaining third being converted to power.

The Two Stroke Engine

Although four-stroke power units are available, the two-stroke engine is still the most commonly used for microlight aircraft, primarily due to their relatively lower cost and higher power to weight ratio. The two-stroke engine is less fuel efficient than the four- stroke per horsepower, although it generates more heat, it also has less tolerance to running lean etc. The two-stroke engine has fewer moving parts than a four-stroke because it does not have complex valve train components.

Feeding the Mixture to the Engine

The need to draw in and compress the mixture, burn it then clear the cylinder (making it ready to accept another charge) is essential to all piston engines, but in a two-stroke design two functions are enacted simultaneously.

It will be seen (in Fig. 58) that no mechanical valve gear is provided. Instead the piston is arranged to cover and uncover ports cut into the cylinder walls thus providing the dual function of compressor/power collector and inlet/exhaust valves.

Imagine the engine is running. As the piston rises to compress a fresh charge, pressure decreases within the crankcase, the inlet port is uncovered by the piston skirt and mixture from the carburettor flows in. The engine fires and during the power stroke the inlet port is closed, and the mixture trapped within the crankcase is compressed by the descending piston. Towards the bottom of the power stroke the piston crown uncovers an exhaust port and at the same time opens a transfer port which communicates between the crankcase and the top of the cylinder (i.e. combustion chamber).

Mixture under pressure within the crankcase now escapes through the transfer port to the combustion chamber. The incoming mixture assists exit of the burned gas through the exhaust port.

Note the design of the piston crown which is contoured to encourage the gas flow just described.

During the next compression stroke a fresh charge of mixture will be drawn into the crankcase ready for transfer to the combustion chamber as the following stroke occurs.

In some higher performance two-stroke engines the inlet port is controlled by either a rotary disk valve or a reed valve. These valves give more control over fuel/air mixture intake timing and result in a greater charge being drawn in each cycle, and hence greater power.

Having regard to the fact that a two-stroke engine produces a power stroke every revolution, one might expect it to develop twice the power of a four-stroke engine of similar capacity.

Spark plug

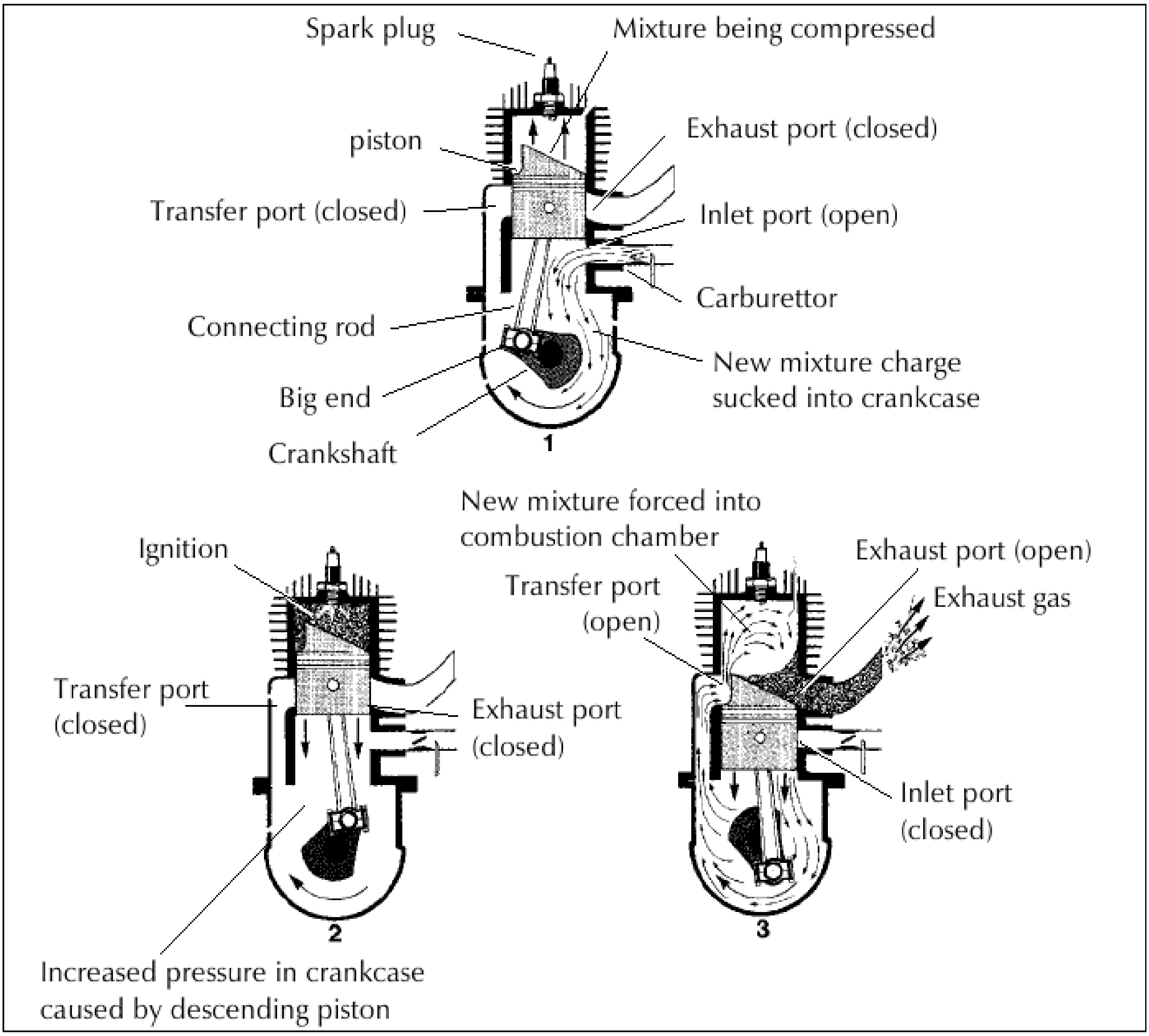

Fig. 58 Typical two stroke engine.

Unfortunately scavenging of the exhaust gas and imperfect induction reduce its efficiency and, on average, a two-stroke will develop only 50 per cent more power than a four-stroke engine of the same capacity. Furthermore, both oil and fuel consumption per horsepower hour is higher for a two-stroke. Against this must beset the advantages of simplicity and low weight per horsepower.

Air Filters

There are only two inputs that are mixed to cause the engine to develop power Petrol and Air.
The Air Filter is an important component that requires regular attention. Regular cleaning of the Air Filter will ensure that the engine does not start to run "rich". If the two stroke engine is caused to run "rich" then a consequence can be that it will "bog down" as the power is applied. This event can be disastrous on final approach. Typically the Air cleaner and the spark plugs are attended to at the same time.

Lubrication

Unlike the four stroke engine with its wet sump or separate oil tank, oil ways, and, in many engines, oil pump(s), two-strokes are lubricated by the simple method of mixing suitable oil with the petrol. When one of the modern oils developed for two-strokes is used the normal mixture is one part to 50 parts of petrol. However this may vary in engine brands, so always consult the manufacturers handbook or aircraft flight manual for the type of oil recommended and amount to be used.
Excessive use of oil will lead to heavy carbon deposits around the exhaust ports and fouled sparking plugs. The petrol and oil mixture (often called petrol) must be thoroughly shaken to ensure even distribution of the oil before refuelling.
Some higher performance two-stroke engines use oil injection, where a metered amount of oil from a separate reservoir is injected into the crankcase inlet on each cycle. This eliminates the need for premixed fuel and oil.

Cooling

In addition to the cooling fins already described in the earlier section, some two-strokes have a small cooling fan attached to the drive shaft. Water cooled engines are also common in higher powered two-stroke engines. These utilize a "water jacket" built into the engine block and head, through which coolant (usual y a 50/50 mix of water and antifreeze) is pumped. Having absorbed heat from the engine, the coolant is then piped to the radiator (usually mounted in the airflow but where it will cause the least amount of drag) which disperses the heat into the surrounding air, thence back to the engine to reabsorb more heat.
Care of water cooling components is relatively simple:

- Check the coolant level before each flight.
- Check hoses and the radiator for leaks or damage.
- Check all mounting hardware for security.

Ignition

Purpose built four-stroke aero engines and some newer two-stroke engines are provided with two independent ignition systems (dual ignition) to:

- ensure safety, and
- provide better ignition of the mixture in what is by automobile standards a large volume combustion chamber.

Microlight engines now have both single plug and dual plug ignition systems, with either solid state, electronic or magneto type ignition.
The spark plugs on either type of engine require regular maintenance. Cleaning or replacing and re-gaping at 25 hours is a fairly typical recommendation.

Engine Handling

Be sure to follow any engine operating procedures recommended by the engine manufacturer.
Proper handling will improve the reliability of an engine greatly.
Some points to remember:

- use of continuous high R.P.M. settings will cause increased strain and wear of components; this may lead to high cylinder head temperatures which in turn can cause detonation and poor cylinder wall lubrication.
- do not use high power settings until the engine has warmed. High R.P.M. causes very rapid wear to a cold engine. Therefore, takeoff must be delayed until cylinder head temperatures are above the minimum.
- the throttle should be advanced smoothly to prevent strain on the engine.
- the fuel mixture and carburettor mixture must be kept at the recommended settings.
- avoid long power off descents which can lead to a spark plug fouling warm the engine periodically.
- remember that at high power and low airspeed (climb), engine cooling will be diminished.
- constantly monitor engine temperatures in flight.
- use full throttle to ensure a richer mixture to reduce overheating and improve lubrication during climb out
- avoid rapid application of full power after a prolonged descent to avoid 'cold seizure'. Warm the engine periodically during descent, and apply power smoothly after descent.

"If you want a reliable engine, look after it!!"

Fuel Storage

Not surprisingly, petrol engines perform well on petrol and not at all on water and other contamination. Ensuring your engine always has a good supply of clean fuel goes a long way toward preventing engine failures. Containers used for fuel storage should be completely clean and without residue of anything else they may have contained. There should be no sediment or deterioration of the inside surfaces. Likewise the associated hoses, funnels and pumps used must also be clean.

Water can mysteriously find its way into seemingly leak-proof containers and microlight fuel tanks by means of the condensation process. To minimise this, keep fuel containers as full as possible.

Fuel drums should be stored on their sides if in the open, so that the expansion and subsequent contraction of the fuel and drum cannot draw in water which has collected in the rim.

On the first preflight of the day and after every refuelling, include a check for water which will collect in the low points of the system, this can best be removed by a drain tap at that point. Drain a little fuel into a glass and water will appear as bubbles on the bottom.

Mixing the correct ratio of the right oil to petrol for two-stroke engines is vital! It may be helpful to draw up a chart showing the appropriate amount of oil for various amounts of petrol. Be particularly careful when mixing fuel in the microlight's fuel tank on an out landing or cross-country stop. Know what you are doing! Your engine manual will specify what octane rating your engine requires.

Only use fresh fuel as it deteriorates with time. Old fuel has a reduced octane rating which may cause engine problems.

Fuel Management

Fuel related accidents usually fall into three categories Fuel contamination, Fuel starvation and Fuel exhaustion. Fuel contamination is covered above. Fuel starvation and exhaustion are the result of poor pilot practise.

Fuel Exhaustion

Is simply running out of fuel. That's it, you've burned every last drop, meaning an engine failure and forced landing. Knowing what sort of endurance you have, plan your flight to have at least 20 minutes of fuel remaining, once the flight is completed. Do not be tempted to reduce this safety margin. There are many reasons for keeping this reserve of fuel such as the situations below, which all eat into your fuel supply:

- unexpected headwinds.
- use of high power settings longer than usual as in multiple takeoffs or climbs to altitude.
- becoming lost.
- the need to divert to another destination due to weather, wind or unserviceability of proposed landing field etc.
- higher than normal fuel flow. Whenever possible take off with a full fuel load. Be thoroughly familiar with your aircraft's fuel capacity and know what sort of endurance you can safely expect at the power settings you use, for the amount of fuel you are carrying.

If you find yourself in a situation where there is doubt that the fuel remaining is going to be sufficient to reach a destination safely, then don't press on, land at the next safe field.

It is far safer to make a precautionary landing with power than an emergency landing without power where landing options are severely limited.

"I think I can make it" is right at the top of the list of famous last words in aviation history.

Remember the useable capacity is not necessarily the total capacity of fuel carried due to the location of the fuel pick up point.

Fuel Starvation

This can occur in microlights with fuel on/off taps and/or more than one fuel tank, where the fuel supply is interrupted by wrongly positioning the fuel tap. It may sound unlikely that anyone would select the fuel off or change to an empty or near empty tank, but it certainly happens.

The obvious cure for fuel starvation problems is to stay aware of your fuel system. The fuel selector would normally be positioned "on" to the appropriate tank before start up and checked again before takeoff during the pre-takeoff checks.

The fuel filter/drain should be checked for contaminants/water, prior to flight.

In flight the pilot should constantly monitor the fuel situation and know beforehand when the change to another tank should be made. Needless to say, don't wait until the "Big Silence" before changing to the new tank either!

Ensure fuel selectors are clearly marked as to their positions and when moving the selector think about your action. Don't rush your preflight checks.

Summary

- Know your fuel system selectors, on/off valves etc.
- Know the useable capacity of fuel on board.
- Know the consumption rates at various power settings for the particular microlight being flown.
- Check for fuel contamination after every refuel.
- Don't change tanks just before takeoff- allow time to verify the fuel flow before takeoff.
- Always check fuel quantity yourself before flight.
- Plan to have easily enough fuel plus reserve for each flight.
- Keep refuelling equipment clean.
- Constantly monitor fuel state in flight.

4. Meteorology

Introduction

This Chapter on Meteorology covers the basic meteorology syllabus. For further reading we suggest you obtain one of the many good publications out there. We recommend the book "Weather to Fly for Recreational Pilots" by W. J. Wagtendonk.

The weather and its changing patterns has always been of interest to man. However, the degree of importance attached to it varies considerably between individuals. For example, a traveller by road or rail is only ever hampered by the severest of weather, whereas the pilot in his aircraft can have his flight affected by even slight changes in weather conditions. One could say that the ground traveller travels underneath the weather, while the pilot travels through the weather itself.

Weather conditions play a vital role in the operation of microlight aircraft. To safely plan a microlight flight knowledge of the anticipated weather conditions is a basic requirement and because weather forecasts cannot be guaranteed, either in their accuracy or availability, the pilot must develop a basic understanding of the elements involved in weather prediction, so that he/she can make sensible decisions prior to and during flight.

The competent aviator has a sound knowledge of and respect for the weather and its relation to flight operations.

A microlight is an aeroplane and it operates in the environment of the air just like any other aircraft. It is therefore essential that a microlight pilot is aware of the problems which result from deteriorating weather and has a basic understanding of how changes in the weather conditions can affect his operations. This does not mean that pilots have to be meteorologists, but rather they must have a basic knowledge of the weather elements and how they interact to produce good or bad flying conditions. They will also need to know the limitation of the weather forecasting services and be familiar with the methods of obtaining weather reports and forecasts.

Although it is the responsibility of the Meteorological Service to provide weather information to pilots in the form of forecasts and reports, it will always remain the pilot's individual responsibility to make wise decisions in respect of whether a planned flight can safely be made.

To the pilot, Aviation Meteorology could be summed up as consisting of four basic elements:

- Visibility.
- Cloud Base.
- Precipitation.
- Wind Velocity.

However, a pilot's role in relation to safe flight operations cannot be achieved unless he is conscious of how these elements may affect his own limitations and those of his aircraft. Therefore, although the information in the following pages is part academic and part practical, it must be understood by any pilot if he is to become capable of assessing the hazards associated with various weather phenomena. Ignorance of this will lead him to taking chances, which in turn can easily result in the occurrence of dangerous in flight situations.

Aviation forecasts and reports

The Meteorology Service provides two main aviation weather services to pilots:

- Information on current weather (reports).
- Information on expected future weather (forecasts).

The distinction between the two functions should be clearly understood.

Area Forecasts (ARFORs) are issued daily and on any significant change in forecast. They give you an overview of the weather situation and the expected weather for the area. It can be useful to get forecasts for adjacent areas if changeable weather is on its way.

Terminal Area Forecasts (TAFs) are forecasts for major controlled airfields in the areas selected.

METARs are hourly reports from most controlled airfields throughout Mongolia. They are also available while in the air. If in doubt, ask for a METAR Report. They are usually available around 10 to 15 minutes after the hour. If your destination does not issue METARs then obtaining one from the nearest manned aerodrome could be of use.

SIGMETs are a heads-up on significant meteorological information (thunderstorms, severe wind, windshear, cloudbase, visibility, etc) in the area. They are issued as required.

No pilot should take off on a cross-country flight without a complete understanding of the ARFOR for his route; TAF for his destination; METARs for his destination, alternate and enroute airfields; and any SIGMETs applicable to his route and destination.

You can also obtain unofficial weather information from a number of other sources. While these are not a substitute for a proper aviation forecast, they can help give you a more complete understanding of the weather you can expect enroute. And there is value in a phone call to someone you trust at the destination field to give you a microlight pilot's perspective on the weather.

The Weather Map

The weather map is the foundation of forecasting. It is simply a map showing weather conditions over an area. Maps are normally updated every few hours. The weather information used in the preparation of a weather map consists of simultaneous observations of such elements as wind direction and speed, cloud form, amount and height, temperature, pressure, visibility etc, taken at a number of stations distributed over a wide area, supplemented with satellite and weather radar data. When this information has been plotted on the chart and the isobars, fronts, etc have been added, the completed chart presents a view of the actual or expected general weather situation.

The weather map below gives a general picture of the weather situation over Mongolia at a given period.

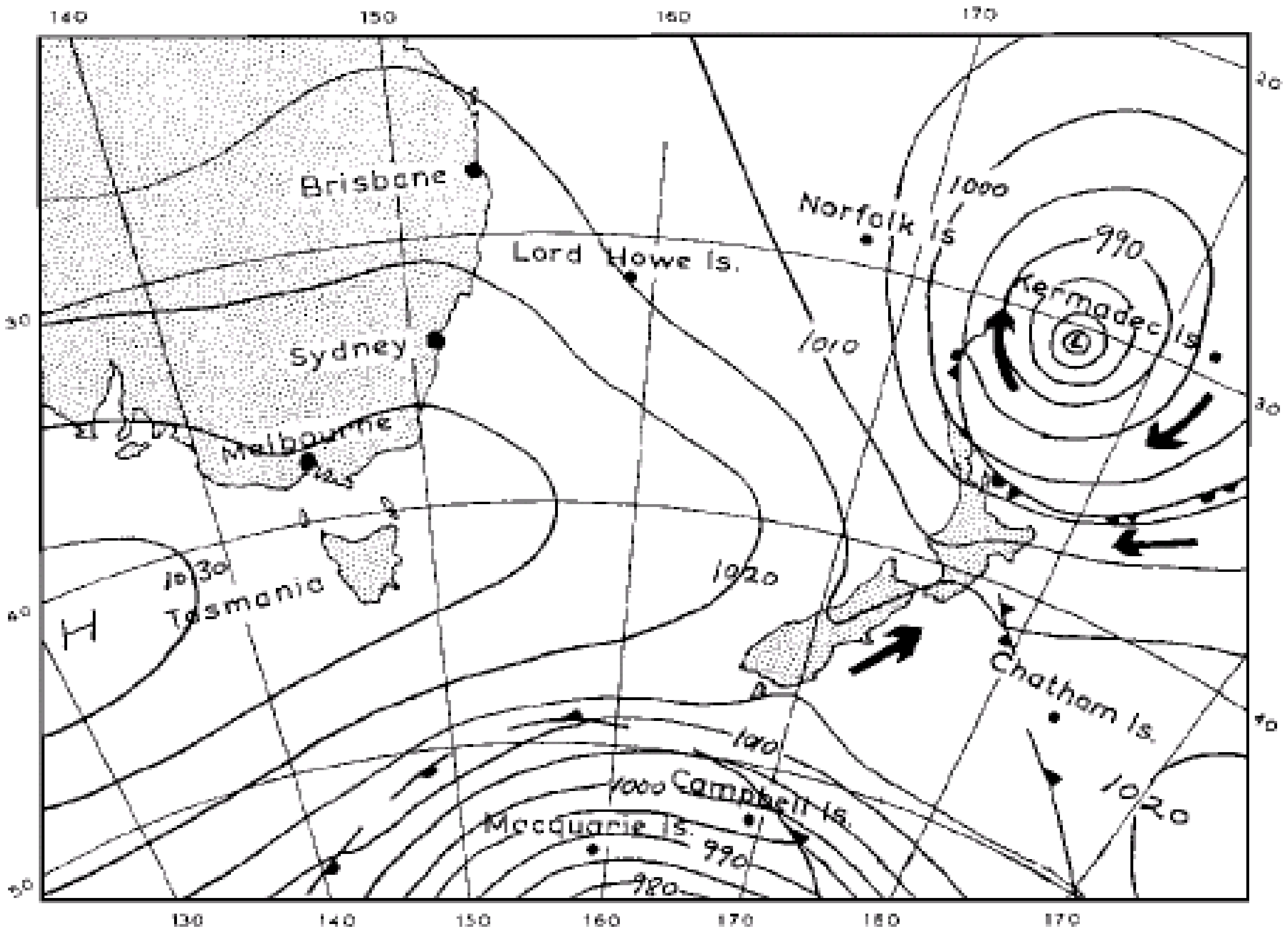

Fig. 89

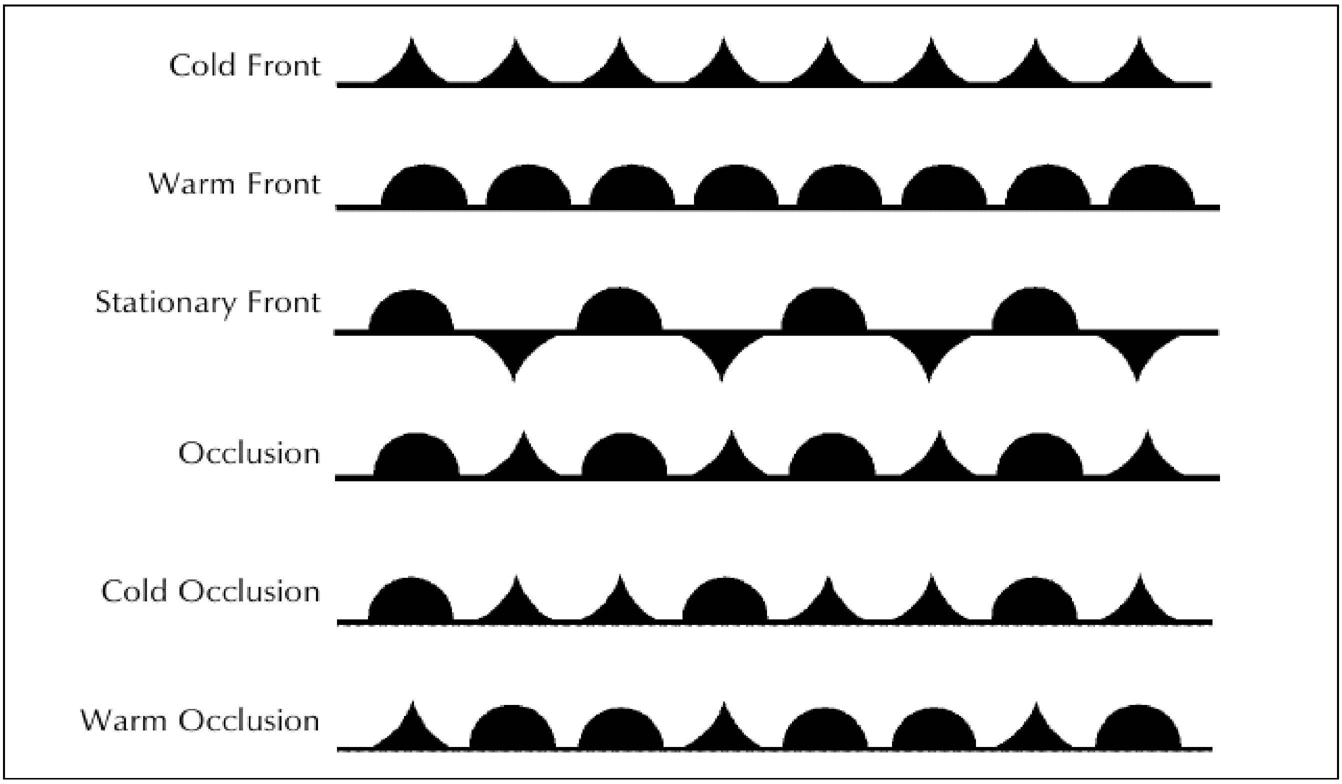

Fig. 90 Frontal Symbols.

The Atmosphere

The atmosphere of the Earth is comprised of approximately 80% volume Nitrogen and 20% Oxygen. It contains a small but very variable amount of water vapour which by changing into water droplets or crystals, can form fog, rain, hail, snow, etc.

Atmospheric Pressure

The **weight of the atmosphere above** results in what is known as atmospheric pressure. At sea level this pressure is approximately 14.5 psi or 1013 hPa. To facilitate the calibration of altimeters this pressure is commonly expressed in hectopascals (aka millibars.

Barometric pressure decreases with height- it also varies from day to day and place to place, but is assumed to be 1013.2 millibars in the Standard Atmosphere at sea level.

The **Standard Atmosphere** is one of the assumed conditions for the calibration of instruments. It is sometimes referred to as the ISO or ICAN standard atmosphere and it assumes the following:

- a sea level pressure of 1013.2 hPa
- a decrease in pressure of 30hPa per 1000ft
- a sea level temperature of 15 degrees Celsius
- and a decrease in temperature (lapse rate) of 2 degrees C per 1,000ft.

Atmospheric pressure is the force per unit exerted by the weight of the atmosphere. Since air is not solid it cannot be weighed with conventional scales. Instead it is measured by means of either a mercury or aneroid barometer, or an absolute pressure transducer.

The mercury barometer is very accurate but too bulky for use in aircraft, so aircraft altimeters are the aneroid type. The aneroid barometer consists of a flexible bellows which is sealed after most of the air has been extracted from it. The bellows contracts or expands in response to the air pressure exerted on it. Electronic altimeters generally use a pressure transducer which has a microscopic version of an aneroid barometer- a sealed chamber etched into the silicon chip with strain gauges measuring the deflection of the chamber walls.

Air Density

The rarified air at greater heights in the atmosphere is lighter than air near the ground. Its density is less.

- The less the pressure the less the air density.
- Also the greater the air temperature the less the air density.

Aircraft and engine performance suffer in reduced air density (density altitude).

As air density and pressure at around 10,000ft is only about 3/4 of normal MSL (Mean Sea Level) value, above this altitude lack of oxygen can cause the pilot and passengers adverse physiological effects. We therefore do not fly without oxygen above 10,000ft.

The Pressure Altimeter

The dial of an aneroid barometer can be graduated in feet instead of units of pressure and the instrument can then become an altimeter. As the change of pressure with gain in altitude is not constant, the altimeter is constructed to read correctly under certain conditions known as the International Standard Atmosphere (ICAN).

This assumes:

- A sea level pressure of 1013.2 mbs at 15 degrees C.
- A temperature drop with height of 2 degrees C per 1,000ft.
- Up to approximately 36,000ft above which the temperature is assumed to remain constant at -56.5 degrees C.

As the above conditions do not always prevail, for instance at times the air temperatures may remain constant or even increase with height, altimeters are not always completely accurate.

Altimeter Subscale Settings

Altimeters can be expected to give the correct reading when they have been correctly set. That is, the position of the needle adjusted to read zero when the altimeter is at the airfield level when carrying out circuit practice (QFE), or to read the airfield height above sea level when on the airfield if doing cross country or local flying (QNH). These settings depend on the air pressure which varies, so the correct pressure setting also varies. Different pressure settings can be adjusted by use of the knurled knob to set the correct pressure in the altimeter subscale box.

QFE

When an altimeter is set to read zero on a particular airfield, when airborne it will indicate the height of the instrument/aircraft in relation to the airfield. This setting is known as QFE and in Mongolia is sometimes used **for circuit flying ONLY.**

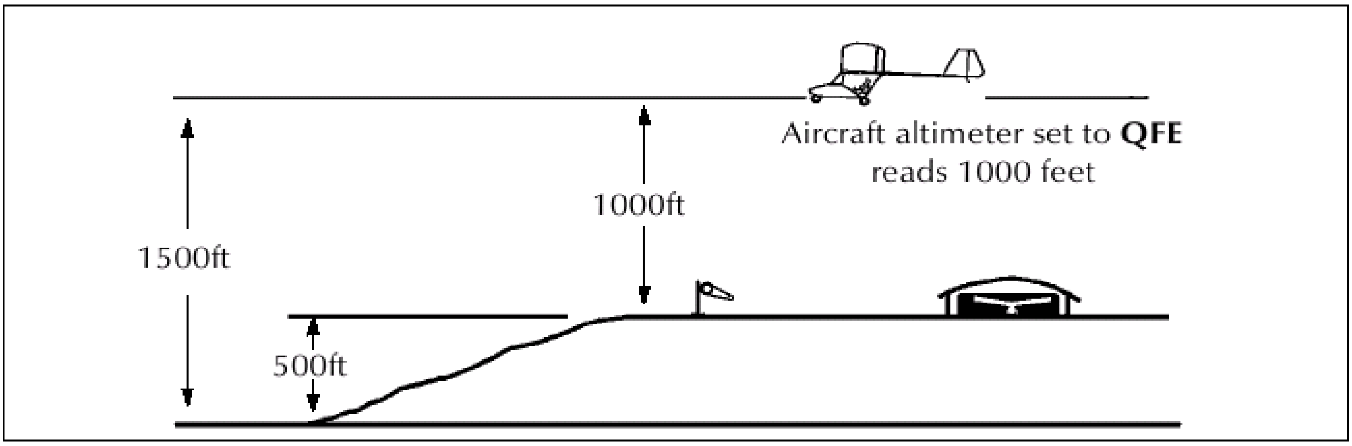

Fig. 91 QFE is where the altimeter is set to read the airfield level pressure. When set the altimeter will read zero on the airfield.

QNH

When the altimeter is set to read the height of the airfield above MSL (mean sea level) when airborne it will indicate the height of the aircraft above MSL **This setting is used at all times in Mongolia except occasionally during circuit practice.**

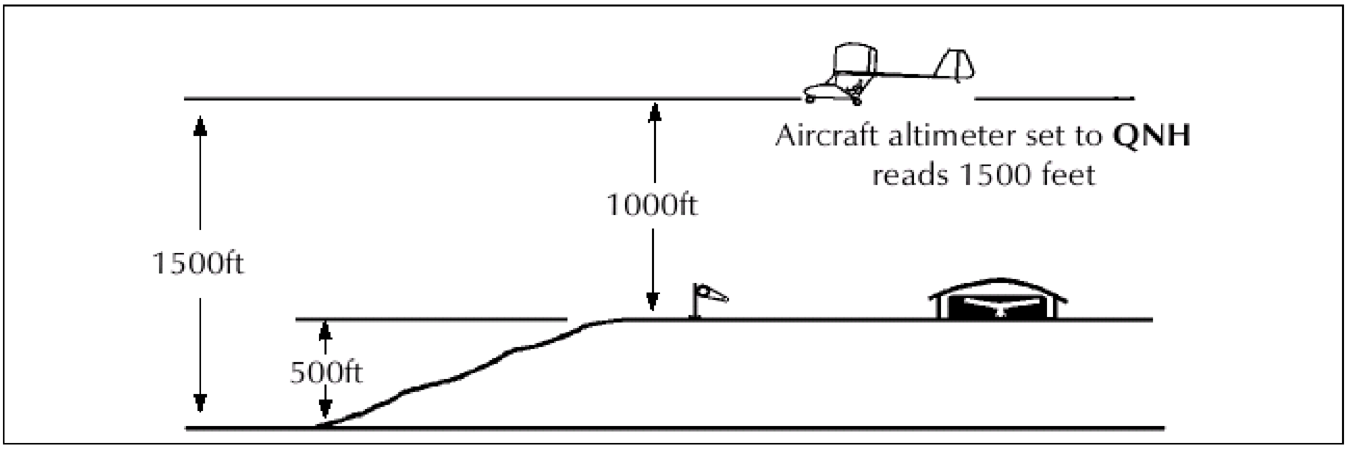

Fig. 92 QNH is where the altimeter is set to airfield level pressure converted to MSL pressure using the ICAN atmosphere.

The altimeter when set on the field will read the height of the airfield above MSL. Values of QNH are always available from Air Traffic Control as required and are the pressure settings always given unless otherwise requested by the pilot. The area QNH is normally given by ATC upon every radio contact and acknowledged by the pilot by reading back.

As an aircraft climbs the pressure decreases and the altimeter indicates an increase in height. Therefore, when flying from an area of high pressure to an area of low pressure the altimeter will read high and vice-versa.

Remember:

- *High Low High* = When flying from high to low pressure the altimeter will read high.
- *Low High Low* = When flying from low to high pressure the altimeter will read low.

Isobars

We have learnt that the atmosphere has weight, and due to the uneven heating of the earth's surface the atmosphere tends to "pile up" or "thin down" in various places causing a direct effect on the weather. The horizontal pressure differences between these air masses provide the force which moves the air over the earth's surface and so produces wind.

Due to the rotation of the Earth, these air masses tend to move in certain general directions in various parts of the world. In Mongolia they tend to move from the West to the East, causing our changes in weather.

Observations of barometric pressure made simultaneously at many locations and corrected to MSL pressure are plotted on weather maps, but the pressure distribution is not apparent until the isobars are drawn in.

An Isobar is a line on a weather (synoptic chart) map joining places of equal pressure at the same height. On your newspaper and TV weather map the isobars are drawn in at MSL. Isobars make up certain well defined patterns to which special names are given.

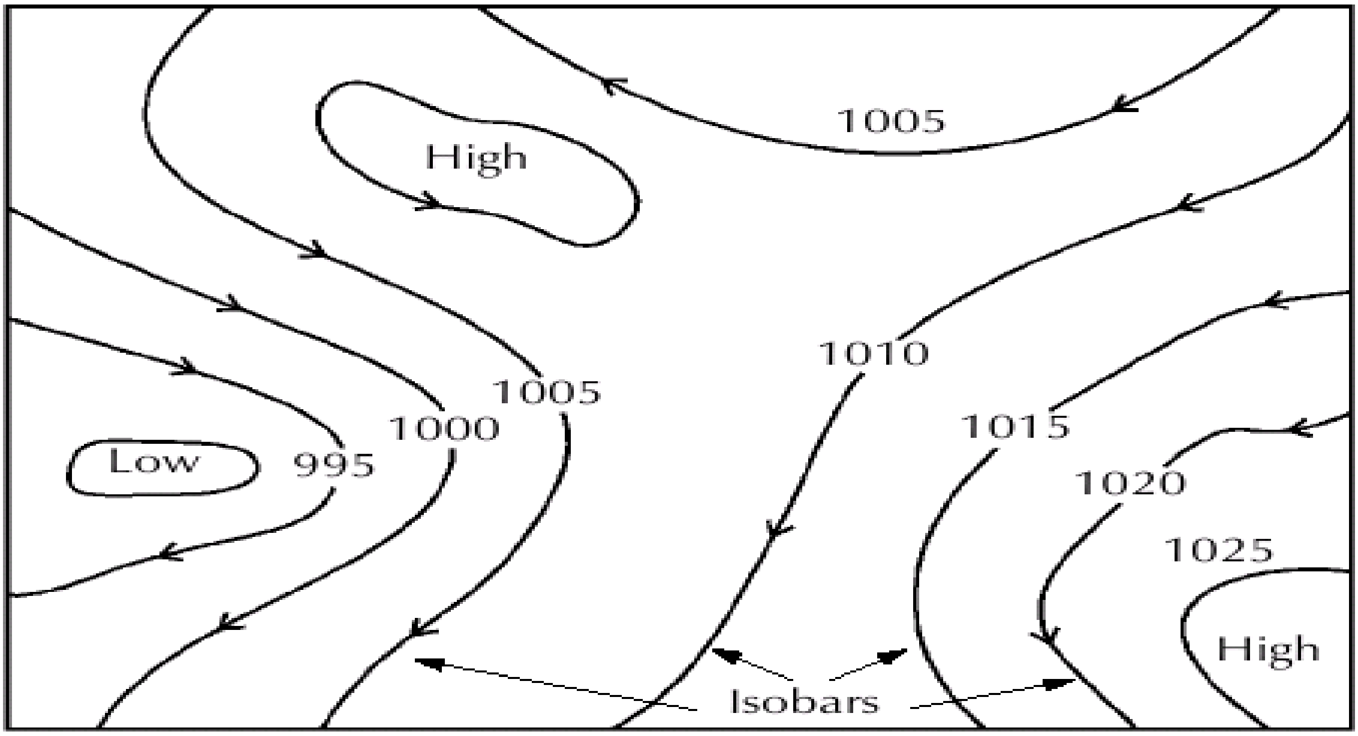

Fig. 93

A **Depression or Low** is a region of low pressure shown by more or less concentric isobars enclosing an area where the pressure is lowest. The isobars are generally fairly close together. The low pressure draws air into the depression where it is sucked up into the atmosphere in a vortex. Air rotation is clockwise around a low in the southern hemisphere.

An **Anticyclone or High** is a region of high pressure shown by more or less concentric isobars enclosing an area where the pressure is highest. The isobars are generally further apart. The high pressure air tends to descend and disperse outward. Air rotation is anti-clockwise around a high in the southern hemisphere.

A **Trough of Low Pressure** is indicated by isobars extending outwards from a low with a higher pressure each side.

A **Ridge of High Pressure** is indicated by isobars extending outwards from a high with areas of low pressure each side.

These defined patterns, or more correctly, pressure systems, move across from West to East and on succeeding weather maps the pattern of isobars tend to retain their shape, but will be seen to change as depressions deepen or highs intensify.

The various types of isobaric configurations are in general associated with certain types of weather and are therefore of particular importance to forecasting. Knowledge of the weather to be expected from the various isobaric configurations can be gained from a regular study of your local newspaper and TV weather map and associated forecast.

For example:

- A high indicates more settled weather over a largish area for longish period of time.
- A low indicates unsettled weather over a medium sized area of shorter duration.
- A ridge indicates settled weather over a smaller area.
- A trough indicates an approaching front and unsettled weather over a localised area.

Air in Horizontal Motion and Wind

Winds are of major importance to microlight pilots. For every takeoff and landing a pilot must consider wind direction, strength and gustiness. On cross-country flights wind must be considered because of its effect on the track and groundspeed.

In a weather report or forecast, **wind speed is always given in knots and the direction in degrees true**, or in points of the compass. The direction is always given from which the wind is blowing, i.e. 090/25, the wind is from the East blowing at 25 knots.

Generally the **wind will back and increase in strength with increase in altitude**. A wind is said to back when it changes anticlockwise and to veer when it changes clockwise.

Gusts are short sudden increases in wind strength and often change in direction. Their cause may be due to mechanical effects such as trees, hangars, etc, or from thermal or frontal activity.

A **squall** is a blast of wind which sets in suddenly, lasts some minutes, then dies away. They are caused by some weather feature such as moving thunderstorms. Squalls often cause a complete change in wind direction for their duration.

Gales are said to occur when the surface wind has reached an average speed of 34 knots or more.

A **Fohn Wind** is a warm dry wind blowing down a mountain range. As a prevailing wind blows up a mountain range, it loses its moisture as rain due to adiabatic cooling then goes down the other side gaining heat due to adiabatic heating of dry air. Because there is less moisture in the air on the downwind side, its rate of change in temperature with altitude (lapse rate) is higher, so it heats up more.

Land and Sea Breezes

These are a feature of coastal districts in settled weather with sunny days and cloudless nights.

The microlight pilot should be aware that the effects of a sea breeze can be noted 10 or more miles inland from the coast on occasion, and may or may not be anticipated in a forecast.

Sea Breeze

During the day the land heats up more rapidly than the sea. The air in contact with the land heats up by conduction, becomes less dense, and so rises in the form of convection currents or thermals. The colder more dense sea air then begins to flow toward the land to replace the air that has risen. This can set up the onshore wind we know as the sea breeze, and it occurs during the day, getting stronger as the day progresses, having its maximum strength around mid-afternoon, and dies away towards evening.

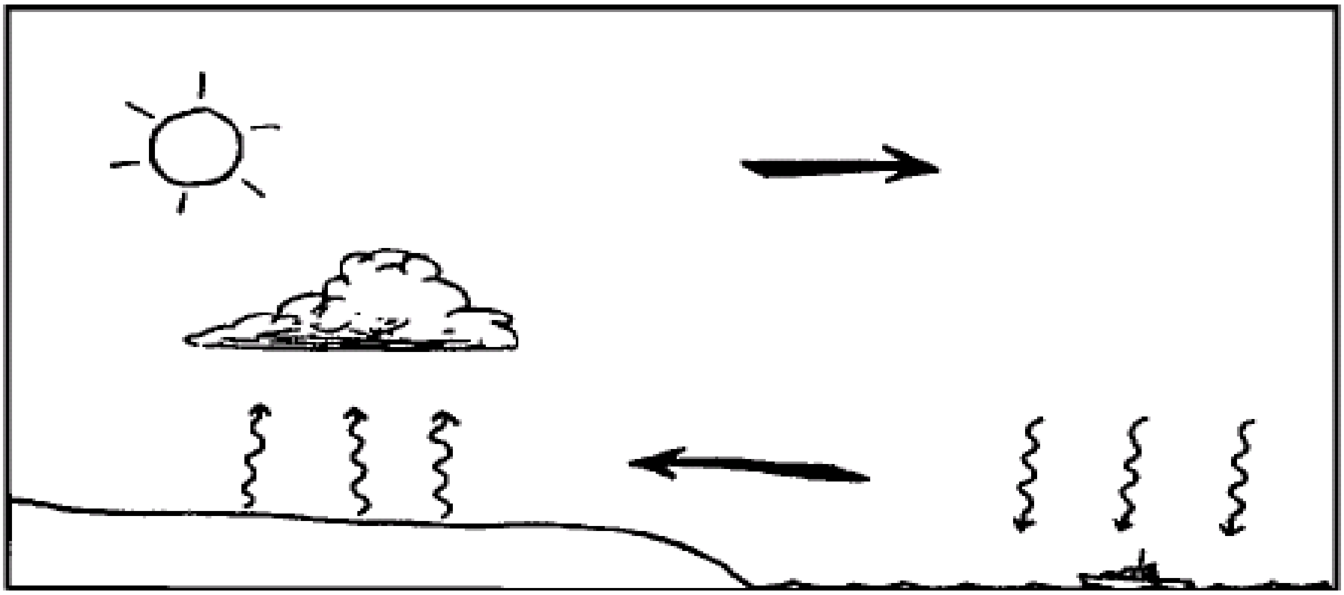

Fig. 94 Sea Breeze.

Land Breeze

A Land Breeze is the reverse of a sea breeze. It tends to occur at night when the land cools more rapidly than the sea and the air over the land becomes colder and more dense than the air over the sea, resulting in a land breeze which sets in only after dark reaching its greatest strength before sunrise.

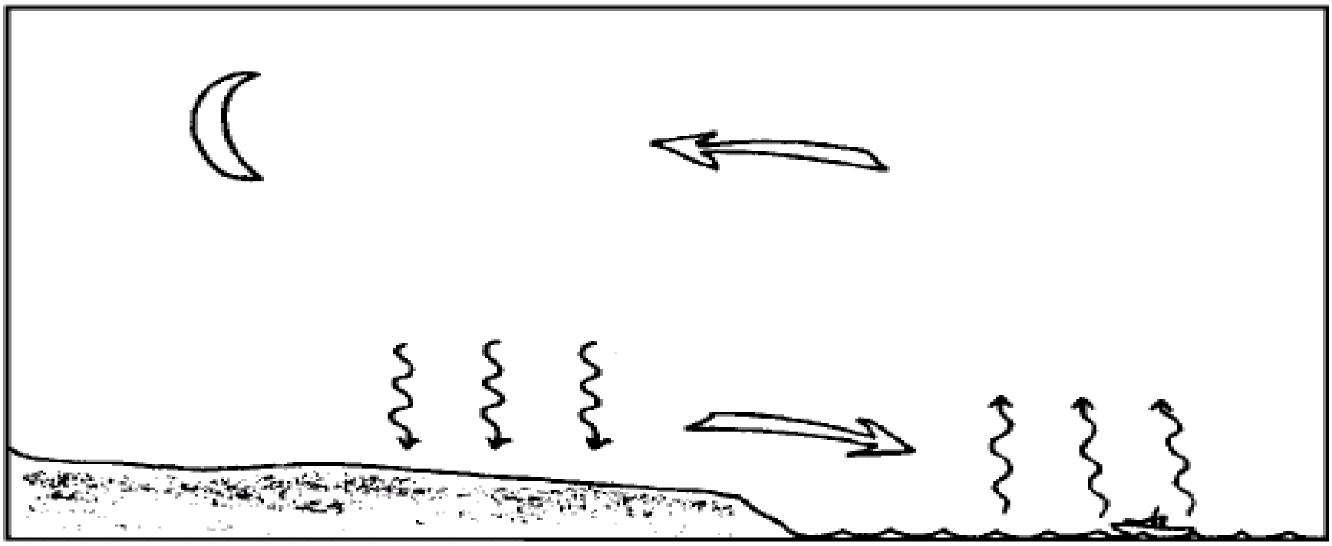

Fig. 95 Land Breeze. The most common small scale effect experienced in hilly terrain is the daytime upslope winds and the evening downslope breeze.

Anabatic wind

In the morning when the sun begins heating the valleys, the different pressures created in the air causes a light breeze to begin drifting up the slopes of the hills. The upslope wind is known as a valley or anabatic wind. Valley winds are the strongest in summer when the sun's heating is the greatest.

Katabatic wind

Downslope winds are termed catabatic or mountain winds. They occur in the evening when the valleys begin to cool. The air lying over the surfaces of the slope cools and slips downward, filling the valley. As the valley fills, the air in the centre is lifted so that a pilot flying in the evening usually finds a better climb rate in the middle of the valley than above the slope (in the absence of ridge lift).

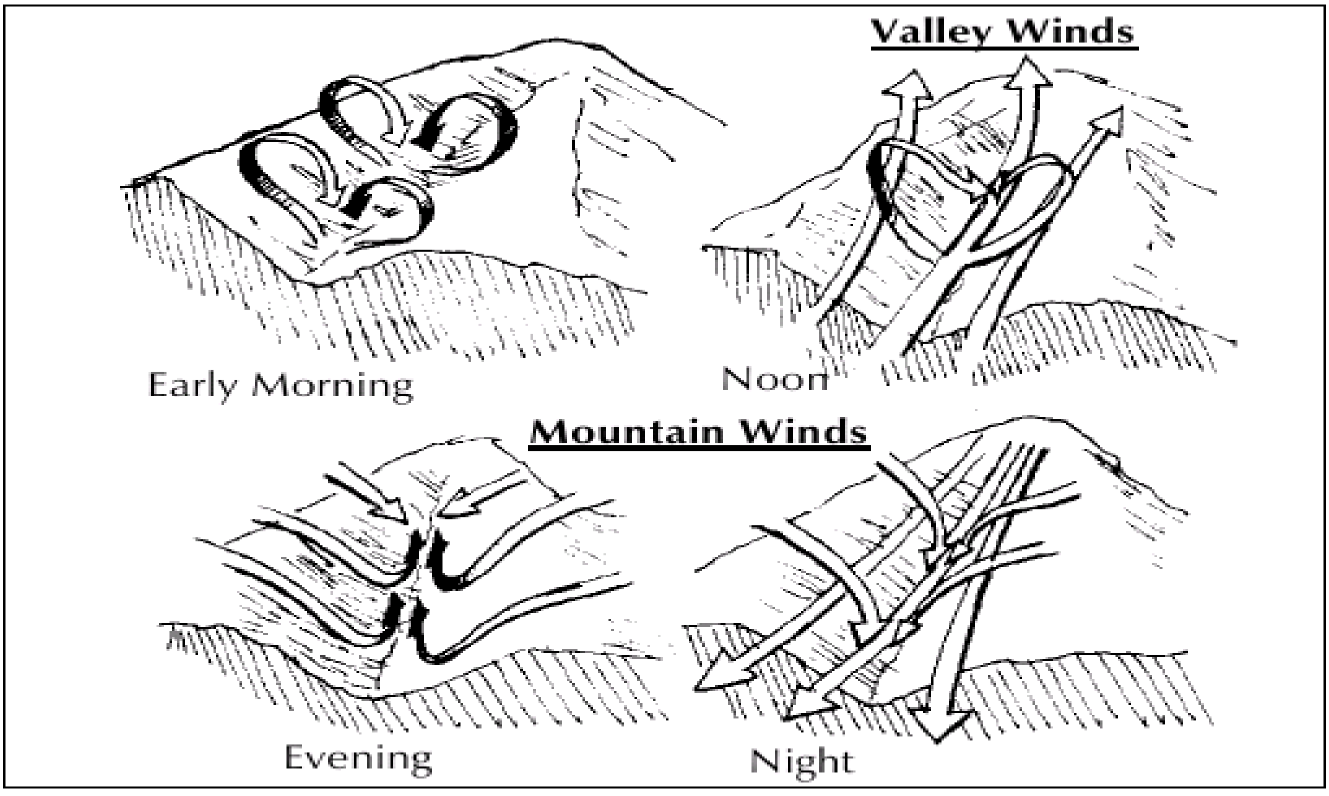

Fig. 96 Circulation due to Solar Heating.

Temperature and Humidity

Air temperature and the way it changes horizontally, vertically, and with time, largely governs the development of the weather. The sun warms the earth by radiation of its heat without heating the atmosphere through which it passes, and the earth in turn warms the atmosphere by conduction. This warm layer of air expands and rises, and thus a thermal is formed. This observed lapse rate can vary considerably in the lower 10,000ft depending whether a cold or warm front has passed through.

Inversion

Generally air temperature decreases as we ascend. If at any time there is an increase of temperature with gain in height, this condition is known as a temperature inversion. An example of this condition is when, during a cold clear night, the air in contact with the ground cools more rapidly than the air at a higher level. This will cause an inversion. If the temperature remains constant as we ascend through an applicable layer, then this is called an isothermal layer.
We can often see an inversion when flying in haze. After a long period of fine anticyclonic weather, the upper air has also become warmed and all atmospheric impurities or smoke and dust are trapped beneath the stable layer of inversion.

Water Vapour

The atmosphere contains water vapour which under certain conditions can condense into millions of tiny droplets of water or ice crystals, which construct clouds and fog. Water droplets and ice crystals tend to fall from clouds under the influence of gravity. Some are supported by rising air currents but others reach the ground in the form of rain, hail or snow.
Air is said to be saturated when at a given temperature it contains the maximum possible amount of water vapour. The temperature at which any given parcel of air becomes saturated is known as its dew point. Once air has cooled to its dew point, any further cooling will cause condensation to take place. That is, the water vapour will turn into water droplets, thus forming clouds, fog or ice crystals if the temperature is low enough. Condensation can be seen on a glass of cold drink, when the air comes in contact with the cold glass, it cools to its dew point and condensation occurs.

Relative Humidity

The term used to express the amount of water vapour present in a sample of air, in comparison to the amount that the air could contain at the same temperature before it becomes saturated, that is, reaches its dew point.

Latent Heat of Condensation

When a solid melts or liquid boils to form vapour, heat is absorbed without any rise in temperature. When a liquid solidifies or vapour condenses, heat is given off without any change in temperature. The latent heat of condensation is the amount of heat given off to change a unit mass of vapour into liquid. Therefore, we can expect a cloud that is forming to be giving off heat and thus increasing the convection currents within that cloud.
The opposite applies to a decaying cloud, hence the greater rate of sink experienced under such clouds.

Air in Vertical Motion

The vertical currents of air, or up and down draughts, are all that a glider relies on to climb in and fly through. They also affect a microlight by causing the flight to be turbulent or bumpy. Actually, the knowledgeable microlight pilot can use this lift in the same way as glider pilots do, enabling fast climbs to altitude using little fuel for example.
These vertical currents vary in strength, reaching violently destructive forces in thunderstorms (towering cumulus and cumulonimbus clouds). These clouds must be given a wide berth by microlights as the turbulence generated (especially by cumulonimbus Cb) can extend 15 to 20 miles away!
The danger from these developments cannot be overstressed.

The interior is a freezing hell of incredibly strong vertical currents, hail and lightning. To enter a Cb would probably result in one being turned into a twisted flesh and aluminium hailstone, and that is no exaggeration. Even large aircraft go around Cb's.
Other air in vertical motion exists in the lee of hills and mountains, and is discussed in the turbulence section.

Stability of the Atmosphere

The intensity of vertical air currents depends on the stability of the atmosphere. In a stable atmosphere a parcel of air tends to resist being displaced vertically and if displaced will return to its original height. On the other hand, in an unstable atmosphere, the air so displaced will continue to rise or fall until its temperature reaches that of surrounding air. The stability or instability is a function of the difference in temperature between the surrounding air and the parcel of air being lifted. On a hot day the ground heats up and by so doing heats the air in contact with it. This forms a bubble which will eventually break free and rise until its temperature matches the surrounding air. The change in temperature with height of the surrounding air is the actual lapse rate.
If a parcel of air is raised for any reason, due to the resulting lowering of pressure it will cool down (like air escaping from a cylinder). If it is lowered (downdraught) due to the resulting increase in pressure it will heat up (like air does when you pump up a tyre). This is known as adiabatic temperature change.

- Dry air will lose 3 degrees for every 1,000ft or approximately 1 degree for each milibar change of pressure, this is the **dry adiabatic lapse rate**.
- Moist or saturated air on the other hand, will only lose 1.5 degrees C for every 1,000ft, this is the **moist adiabatic lapse rate**. The lower lapse rate is because the water molecules add thermal mass to the air.

Flying Conditions: Unstable Air

A pilot flying in unstable conditions is likely to encounter clouds of the heap or cumuliform type, possibly containing quite violent down draughts, the flight will be bumpy and there is likely to be showers and possibly thunderstorms.

Flying Conditions: Stable Air

A pilot flying in stable conditions will have a smooth flight and any cloud encountered will be of the layer type. The weather will usually be fine although drizzle cloud may occur. Surface visibility will be moderate to poor owing to the concentration of atmospheric impurities beneath the stable layer.
Often fog or mist or haze could be experienced in these conditions. Visibility above an inversion layer or above cloud will be good, but remember it is illegal to operate a microlight above cloud.

Clouds

Clouds are formed when rising air is cooled by expansion until the dew point is reached. Fair weather clouds are formed late morning and afternoon when the air is heated sufficiently that it rises high enough for this to happen. There will be blue days when the lapse rate changes such that the rising of air to the dew point night is prevented. Clouds can also be formed by air being forced to rise in front of a front or over a mountain range, if fact anything which causes air to rise or cool can cause cloud formation. Not only do clouds obscure ground features and other aircraft, but they often envelop high ground and may be associated with turbulence or ice formation. Cloud cover is Sky clear, Few, Scattered, Broken, or Overcast.

- Sky clear (SKC) = 0/8.
- Few (FEW) = 1-2/8.
- Scattered (SCT) = 3-4/8.
- Broken (BKN) = 5-7/8.
- Overcast (OVC) = 8/8.
- Cloud base is given as the lowest point at which the base is likely to form.

- Cloud base in weather reports and terminals is given as the height above the airfield level. In route forecasts it is given as the height above mean sea level.

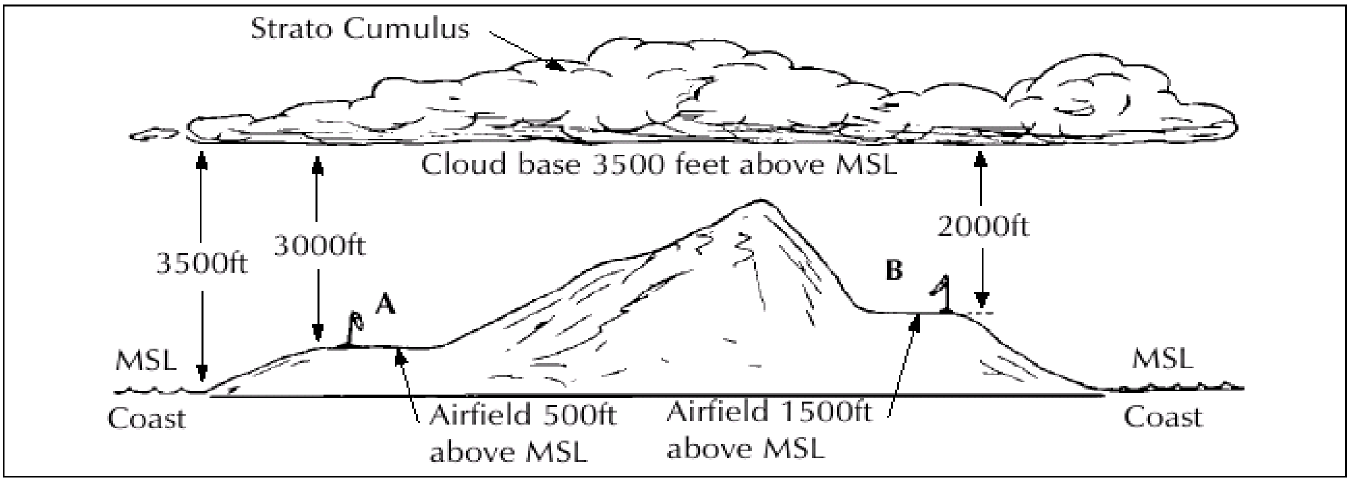

Fig. 97 In the above, if a flight route forecast was required for a coast to coast flight, the cloud base would be given as 3,500ft. A terminal for airfield A would give the cloud base as 3,000ft and for airfield B, 2,000ft.

Cloud Classification

Class	Family	Abbreviation	Likely range of cloud base and tops
High	Cirrus	Ci	20,000 to 40,000
	Cirrostratus	Cs	20,000 to 40,000
	Cirrocumulus	Cc	20,000 to 40,000
Medium	Altocumulus	Ac	7,000 to 20,000
	Altostratus	As	7,000 to 20,000
Low	Nimbostratus	Ns	1-2,000 to 2-7,000
	Stratus	St	500 to 2-4,000
	Stratocumulus	Sc	1-2,000 to 2-4,000
Marked vertical	Cumulus	Cu	1-3,000 to 7,000 development
Marked vertical	Towering Cumulus	TCu	1,000 to 10,000 development
Marked vertical	Cumulonimbus	Cb	500 to 20-40,000 development

Strato or stratus refers to a layer type cloud. *Nimbo or nimbus*' refers to a type of rain producing cloud.
Cloud consists of water droplets or ice crystals or a mixture of both. At temperatures above 0 degrees C (freezing point), clouds consist almost entirely of water droplets, whereas at lower temperatures and at cirrus cloud level, ice crystals predominate.
Water droplets do not necessarily freeze immediately the air falls below freezing point. Small droplets can persist to temperatures as low as 40 degrees C and are called **supercooled**. They are the most common cause of airframe icing.

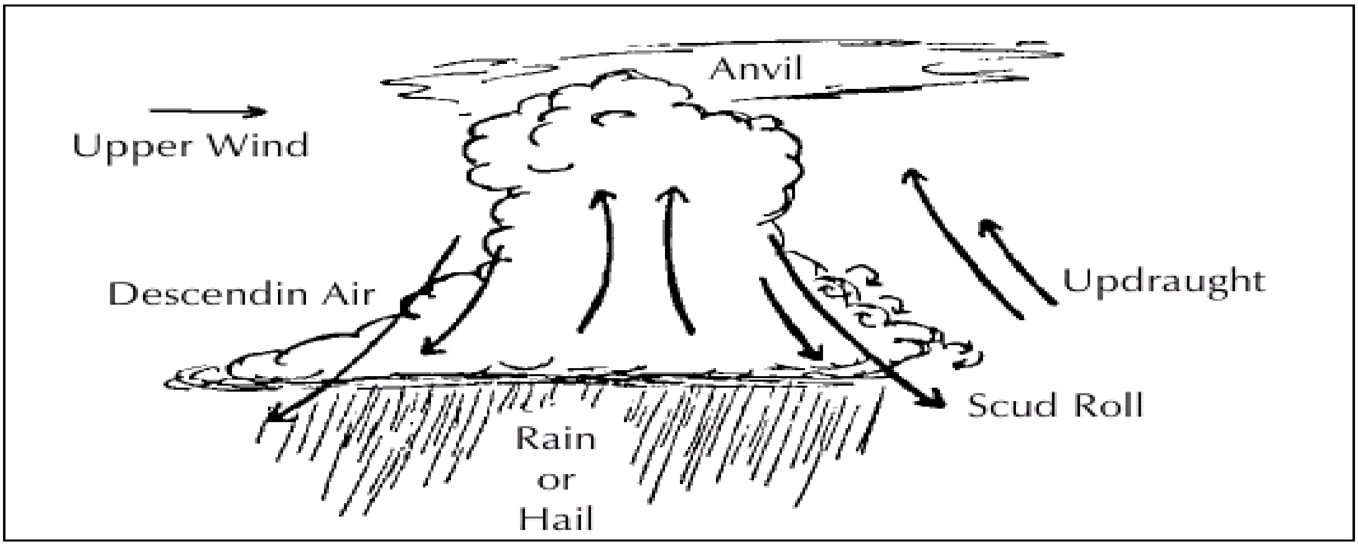

Fig. 98 Cumulo Nimbus Cloud and associated turbulence.

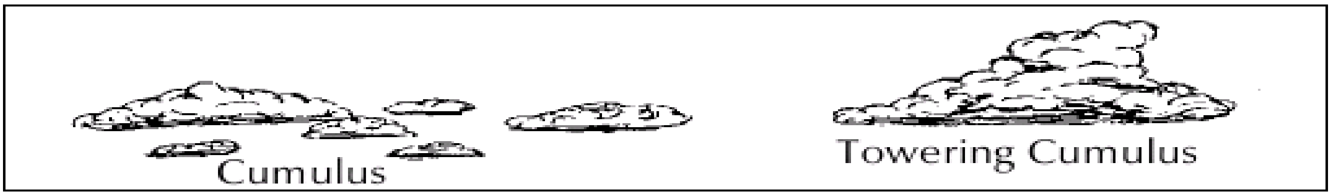

Fig. 99 Cumulus types indicate instability in the atmosphere, thermal activity.

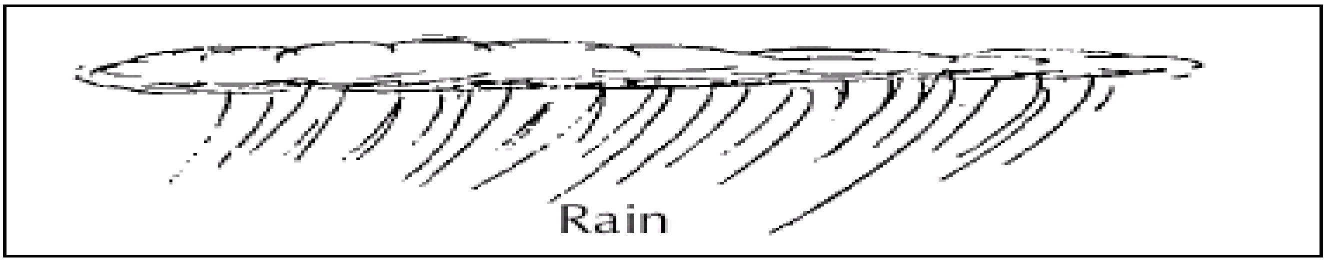

Fig. 100 Nimbo stratus. Fairly continuous layer, often dark looking with widespread rain.

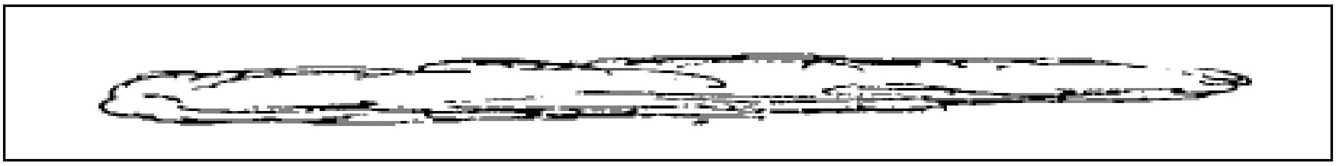

Fig. 101 Stratus. Fairly continuous layer. Smooth conditions.

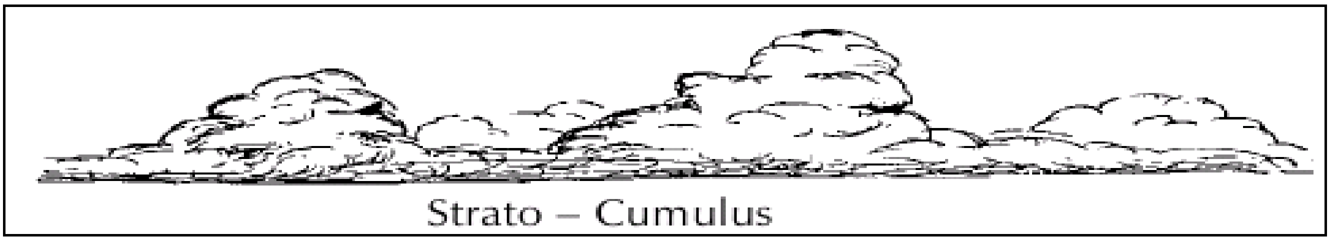

Fig. 102 Fairly continuous layer with cumulus type development.

Figs. 100-102 are stratus type clouds which are often in contact with the terrain.

Cold Front

When a cold air mass is displacing a warm air mass, then a cold front is said to exist at the intersection. Cold fronts usually travel at around 10-15 knots, and pass fairly quickly. It is preceded by cumulus and cumulonimbus clouds forming a "rain belt" usually some 50-60 miles through.
Flying conditions prior to the cold front are usually increasingly turbulent, with generally high cloud and good visibility. As the front passes there is likely to be heavy rain- perhaps hail and thunder. The wind may veer a little with squalls dying out as the front passes. Behind the front the weather will be quite good with good visibility and ceilings.

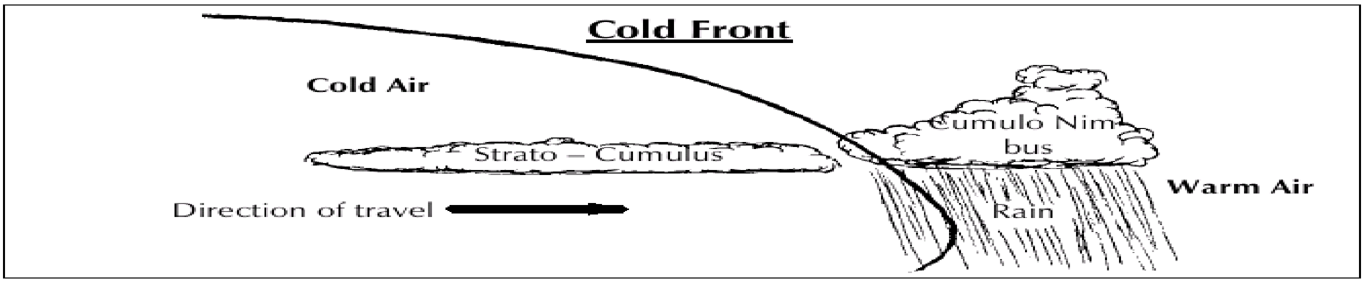

Fig. 103

Warm Front

When a warm air mass displaces a cold air mass, then a warm front is said to exist at the intersection. Warm fronts pass slowly and are preceded by some 500-600 miles by cirrus and cirrostratus cloud. As the front approaches, the cloud will thicken and the base will lower. Rain will usually begin 250-300 miles ahead of the front.
Flying conditions prior to the front are not good, with poor visibility, rain and possible airframe icing. As the front passes the rain or snow may stop or reduce but visibility will remain poor, often with fog or mist.
Behind the front the weather will be fair or drizzly with continuous poor visibility. Fog or mist may remain.

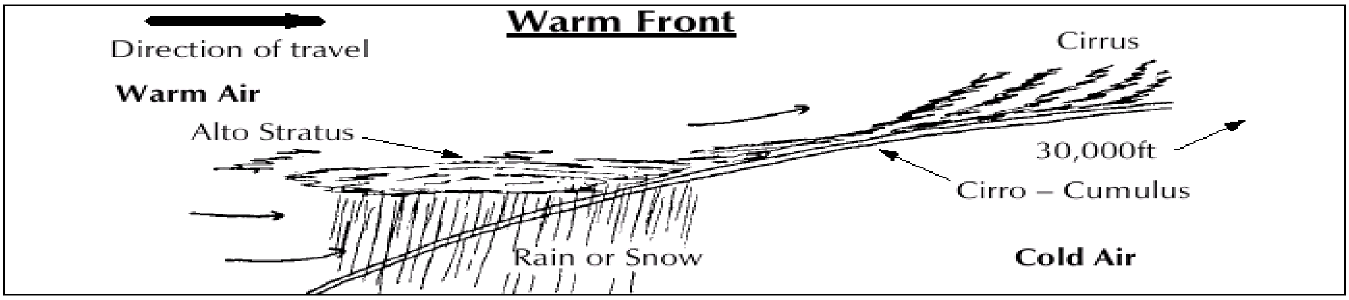

Fig. 104 At times a front may remain stationary, it is then known as a **stationary front**.

It is represented on a synoptic chart by an alternate red and blue line or by:

Fig. 105 Stationary front

As a cold front moves at a higher speed than a warm front, it is common for the cold front to overtake the warm front. The front is then said to be **occluded**. It will then slowly disperse. It is represented on a synoptic chart by a double red and blue line or by:

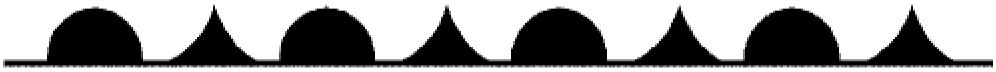

Fig. 106 Occluded Front

Fog (Radiation Fog)

Fog is really only cloud formed close to the ground. Fog occurs on cold clear nights in settled weather with a wind of less than 10 knots.

During the night the Earth's surface cools rapidly and cools the air in contact with it.

- If the dew point of this air is reached, dew will form on the ground.
- If there is a wind of less than say 10 knots, fog will form.
- If there is more than 10 knots of wind, low stratus cloud will form.

If fog forms it will tend to thicken for a period around sunrise due to the mixing of air by convection currents. It may also increase as the air continues to cool until the sun is well up in the sky. Once the temperature rises above the dew point of the air, the fog will disperse. If there is cloud cover above the layer of fog, the fog may persist for a long period - perhaps all day.

Any microlight pilot who considers taking off with the intention of climbing above the fog and expecting it to disperse by the time he lands is not only breaking regulations, but is asking for trouble. It is impossible to gauge the thickness of fog from the ground, and it could easily be several thousand feet thick, despite the tempting blue "holes" one can sometimes see.

Furthermore, even if he managed to control the microlight long enough to get "on top" without reference to the ground he will soon be lost and the fog may last longer than the fuel supply! The tendency is to not take fog seriously and this is sad because it holds the same dangers as any other cloud flying. (See Cloud Flying section.)

General Weather

Getting to grips with meteorology may seem a difficult task initially and it is in fact a very complex and diverse field, but the microlight pilot who has the basics along with good observation skills can soon become a good judge of weather. Don't just look at the sky on days you are about to go flying. Evaluate the weather every day by listening to radio forecasts, looking at newspaper and TV predictions, and relating this to your own observations. Become a habitual sky watcher, noting wind direction and strength along with cloud development as the day progresses. On days with cumulus developments for example, you can watch the cycle of the cloud's birth, growth and decay. Some days you will observe the growth of many cumulus to form a continuous layer as they merge together. This is called over development. With the sun blocked out, the thermal source of this growth is cut off, and the cloud decays to begin the cycle again.

Such things go largely unnoticed by the public, but the microlight pilot should develop a weather eye that notes what is happening in the atmosphere every day. Those newspaper weather maps provide an interesting study. For an exercise, cut out and keep each days map for a couple of weeks and you can form a "cartoon strip" of the weather. Add your own observations each day and see how this fits with the prediction.

A useful point to remember is that the closer together the isobars are, the stronger the wind will be at that place.

5. Air in motion

FLYING IN WIND

Wind is simply a mass of air moving over the earth's surface. An airborne microlight is flying in that moving mass of air. The wind has no effect on the microlight itself (turbulence excepted see turbulence section) but does have an effect on its path over the ground and its speed relative to the ground (ground speed).
It is vital to understand the difference between airspeed and groundspeed.

- **Airspeed** is the speed of the microlight through the air.
- **Groundspeed** is the speed of the microlight over the ground.

The two are completely separate and different values!
Airspeed is an important factor in controlling the microlight in the air and groundspeed is only a measure of progress over the ground, having no relevance to the flying characteristics of the microlight whatsoever.

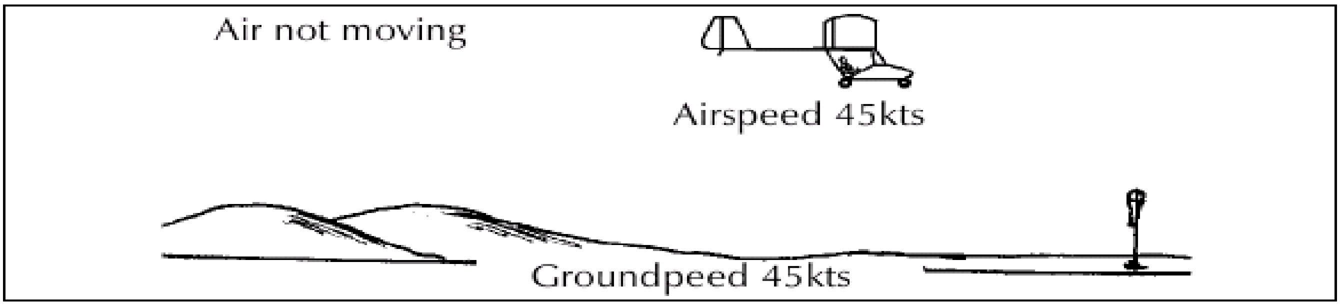

Fig. 59

Effect of a direct headwind

Flying into a direct headwind reduces the groundspeed by a factor equal to the wind speed.

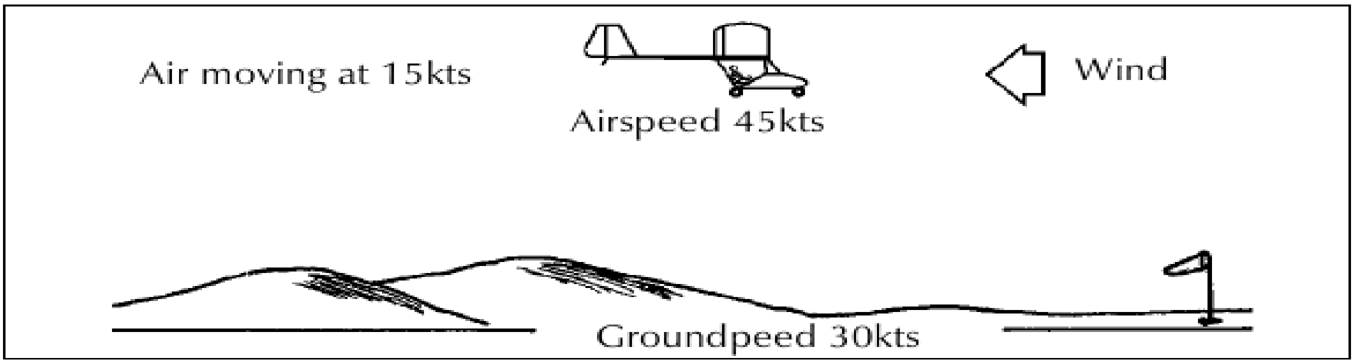

Fig. 60 The reduced groundspeed means more flight time needed to reach a destination (i.e. more fuel required) and there will be an illusion of slow airspeed.

Effect of a direct tailwind

A direct tailwind increases the groundspeed by a factor equal to the wind speed.

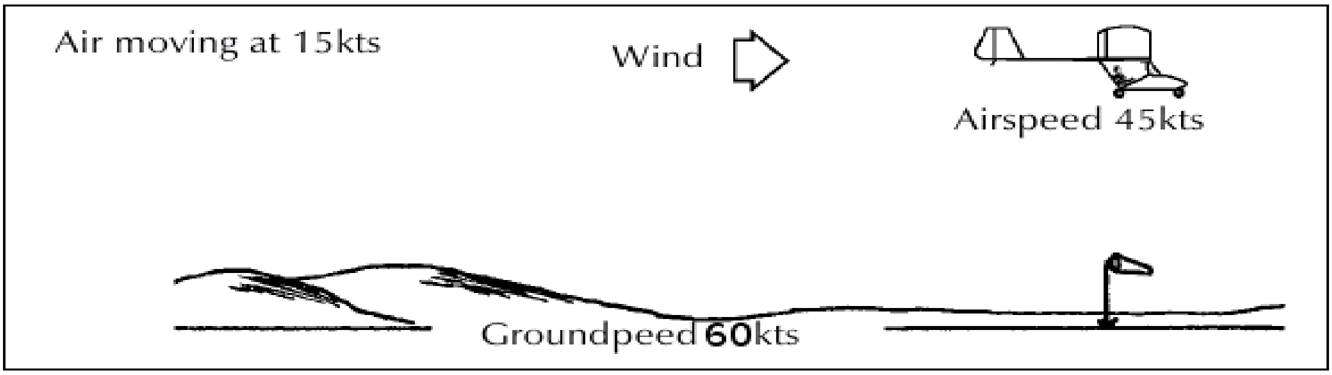

Fig. 61

The increased groundspeed gives a faster time to reach a destination and gives an illusion of faster airspeed. This illusion of extra airspeed will be more pronounced when near the ground and can be dangerous if the pilot slows down to what his normal speed "looks like" in nil wind, thus possibly resulting in a stall. During a cross-country, every pilot loves a tailwind.

CROSS WIND

A wind blowing across the desired flight path (crosswind) will carry the microlight off the desired path in the direction the wind is blowing.

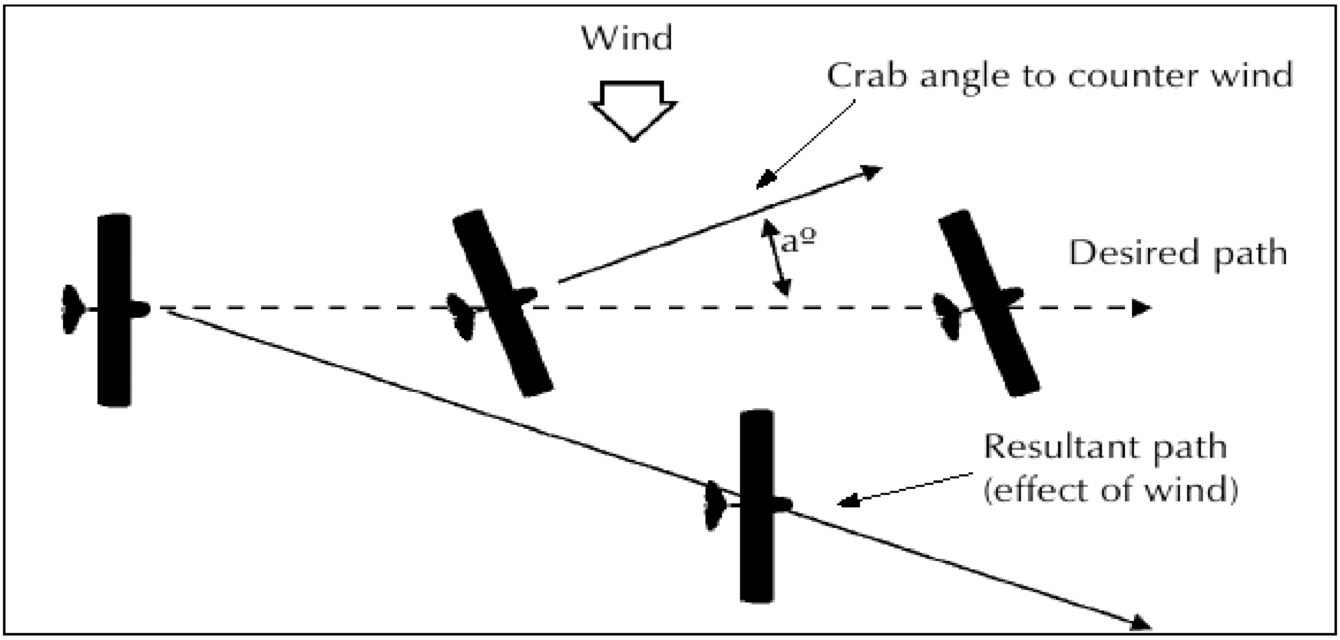

Fig. 62

To counter the effect of a crosswind a balanced turn should be made into wind until the effect of the crosswind is halted and the track made good is along the intended flight path. This is called crabbing. See Fig. 62.
Initially it may seem strange to have the nose pointed away from your destination, but correcting for drift in this way ensures the quickest time between points.
Of course, there are variations of headwind, tailwind, and crosswind components.

Effect of Wind on Climb

Firstly it must be stated that wind from any direction will not have any effect on **rate of climb**. However, wind will effect the **angle of climb**.

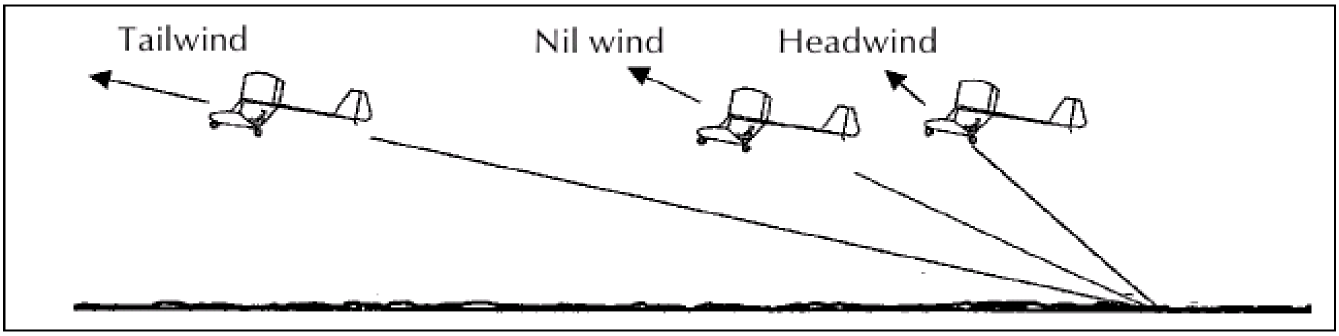

Fig. 63 Effect of wind on climb angle.

Climbing with a tailwind means the groundspeed is increased while the rate of climb remains the same as normal. This translates to a flatter climb angle relative to the ground.
A pilot climbing with a tailwind has to remember there is going to be an illusion of speed and the aircraft may feel as though it is not climbing properly. Therefore the pilot must be sure to maintain normal climb airspeed, and beware that the flatter climb angle could affect obstacle clearance. Rate of climb is unaffected.
Climbing with a headwind means the groundspeed is reduced while the rate of climb remains the same as normal. This translates to a steeper climb angle relative to the ground. Rate of climb is unaffected.

Effect of Wind on Descending

The same principles apply to a descending microlight. Angle of descent relative to the ground will change, while rate of descent will not.

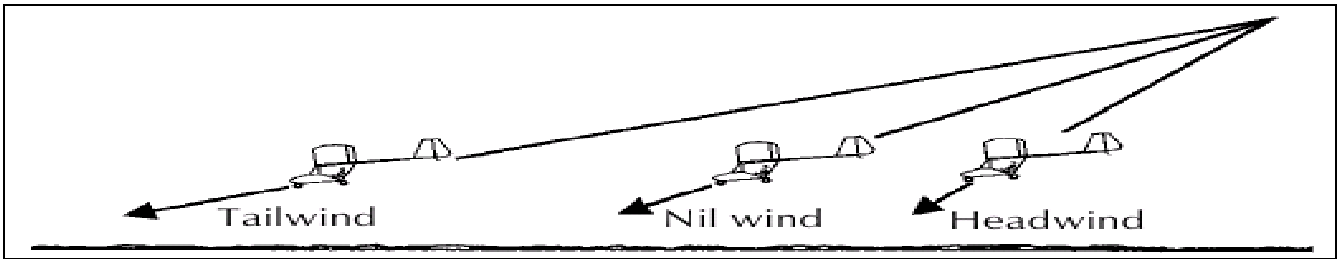

Fig. 64 Effect of wind on descent and glide angle.

Effect of Wind on Gliding

The same principles apply to a gliding microlight. The important thing to remember is that a headwind will greatly reduce the distance a microlight is capable of gliding, while a tailwind will extend the glide distance. These are vital considerations during a forced landing.

Effect of Wind on Turning

If you were to observe from the ground, a microlight with a smoke generator making a 360° turn of constant angle of bank and rate of turn, the smoke would describe a perfect circle even if there was a ten knot wind blowing. However, the microlight's ground track would look very different!
During the turn in the wind, the microlights ground track was affected by the wind. Let's use an example of a microlight flying with a direct crosswind from the path over the ground. If the pilot commences a constant rate turn to the left, the microlight will be helped along its ground path to the left by the wind from the right.
Visually, it will seem that the microlight is accelerating rapidly and turning too fast for the angle of bank (slipping). The pilot may even feel that the aircraft is losing height.

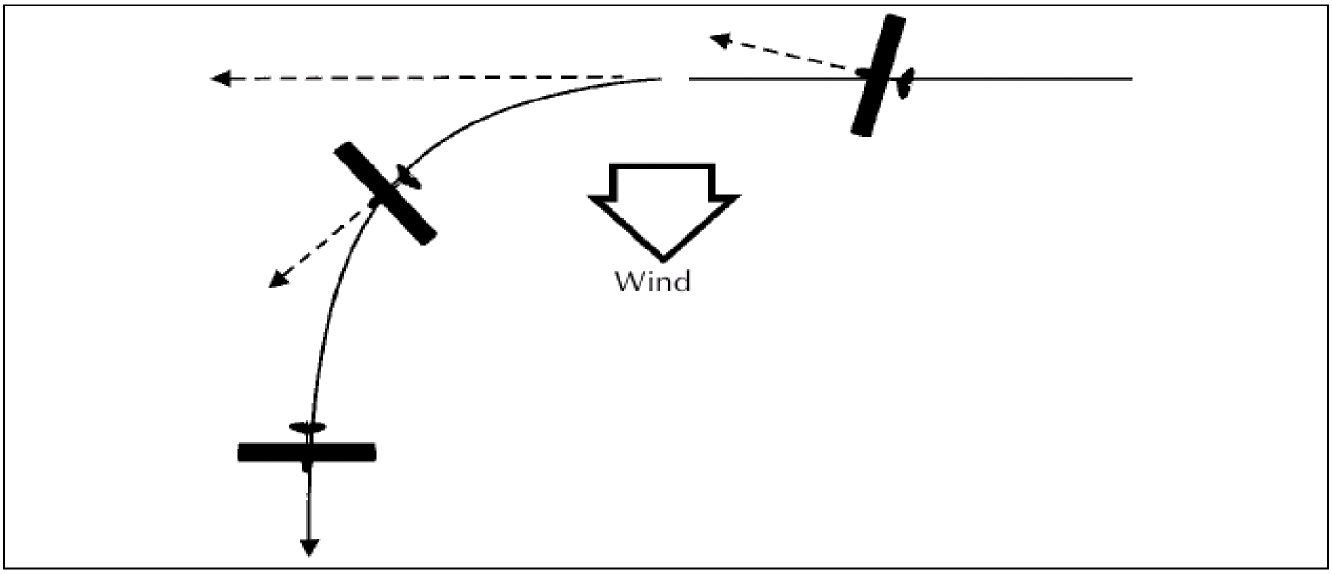

Fig. 65

Now the microlight is in the downwind portion of the turn and it seems to be going very fast because the ground is flowing by quickly. As the turn continues it will appear as though the aircraft is sliding out of the turn and that it is not turning very well. The pilot may tend to steepen the bank.

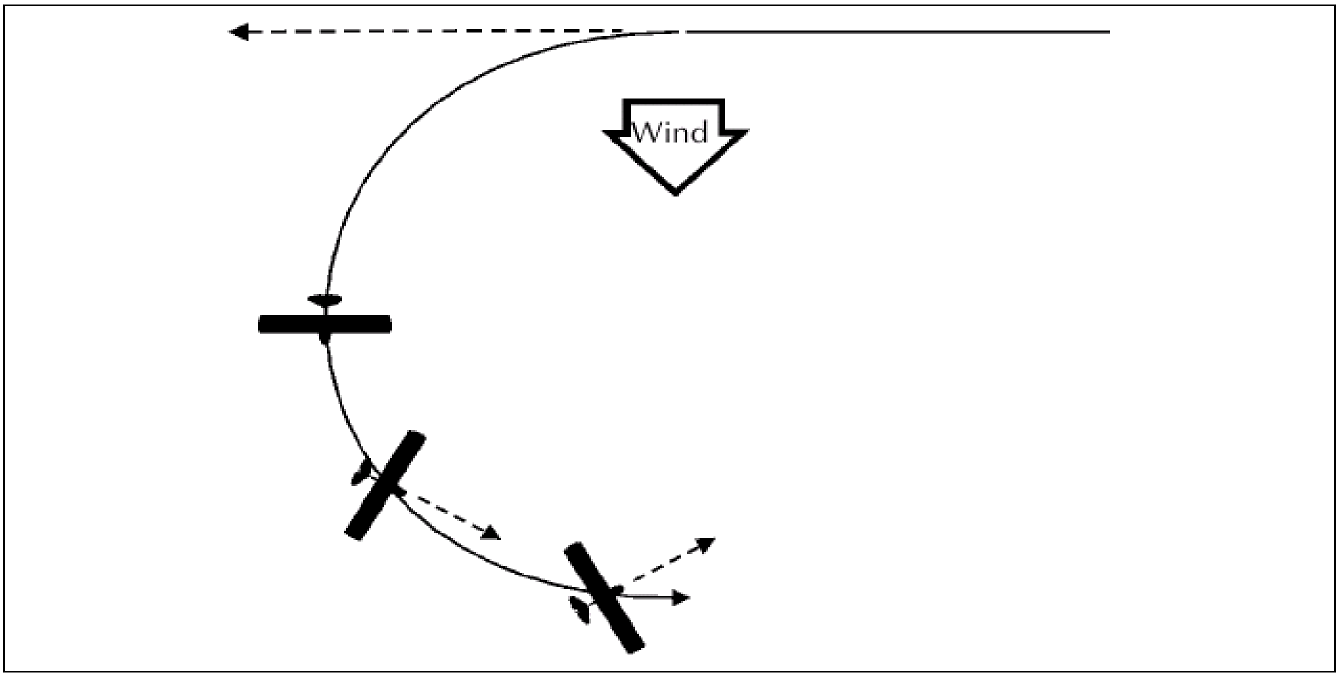

Fig. 66

The microlight is now in the crosswind position again and it will seem to be flying sideways (skidding). As the turn continues into the upwind position it will appear to be slowing as the groundspeed reduces.

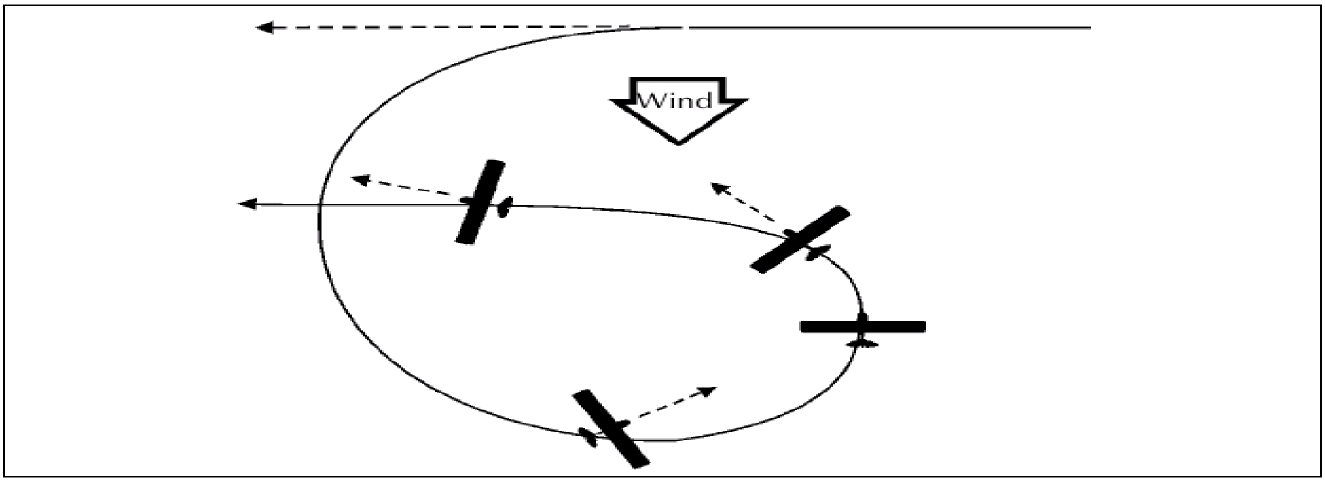

Fig. 67 The turn is completed with another apparent slip to the left as it resumes its crosswind course.

We can now see that reference to the ground gives a false impression of what the aircraft is experiencing while making turns in the wind. It is vital to fly balanced, correctly banked turns at the proper airspeed, disregarding any illusions gained from looking too closely at the ground.

An aircraft is flown in relation to the air it is flying in, and not by reference to the ground.
However, there are times when we wish to fly a course in relation to the ground and it is here that we use our knowledge of how the wind affects our groundspeed and ground track, to adjust our path through the air to achieve the desired result.
The constant radius turn is an example. This is a turn where the desired result is a turn around a point on the ground which gives a ground track of constant radius around that point. See Fig. 68.
In still air this is relatively easy as a constant rate turn will give the constant radius ground track around the point. If there is a wind blowing however, the turn will have to be modified, to compensate for the effect of the wind.

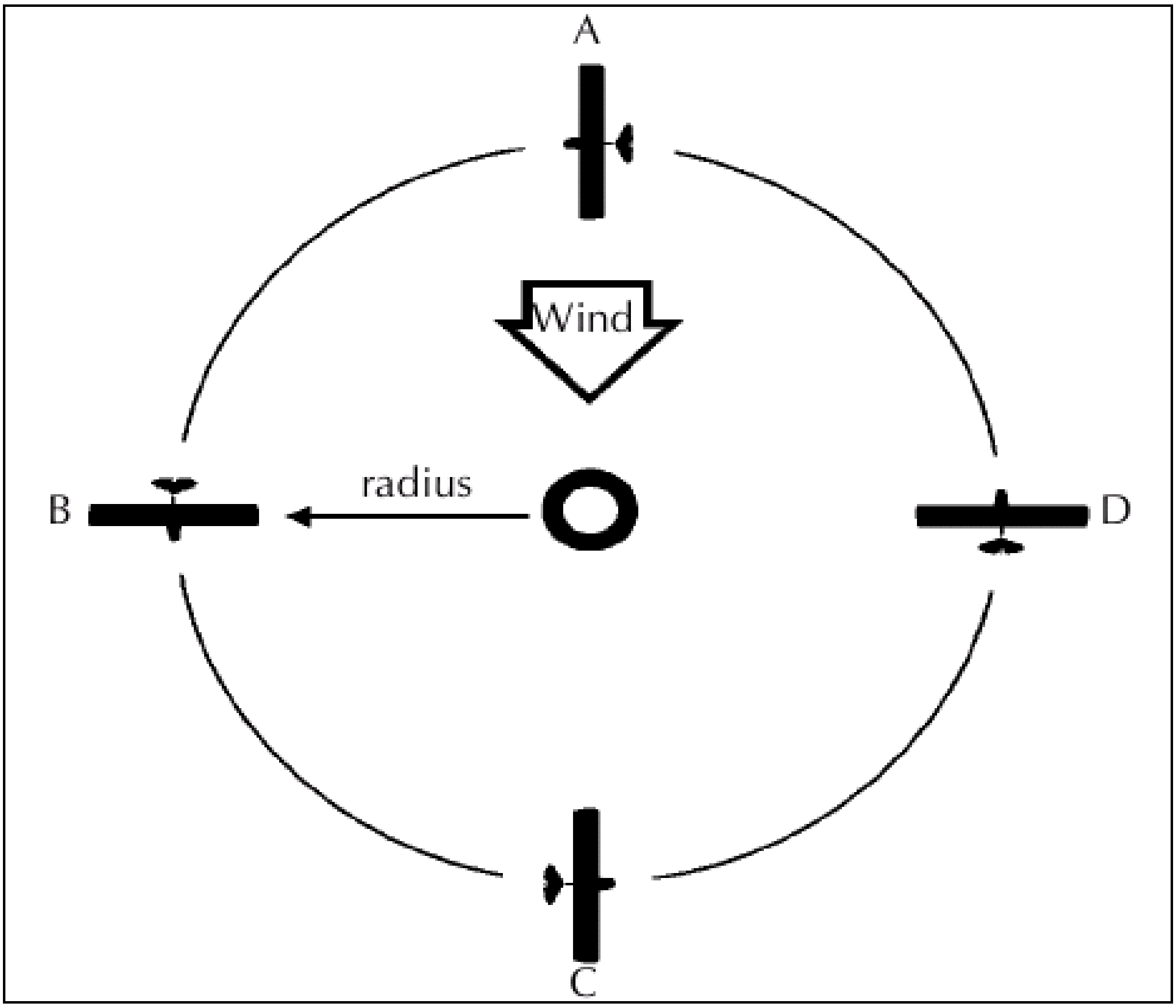

Fig. 68 Constant radius turn.
In our figure the turn is commenced at point A being careful not to use too much bank as the wind aids our path to point B. At point B the angle of bank will have to be increased until at point C the bank is at its steepest and starts to reduce again approaching point D and to point A again.
Remember:

- maintain correct airspeed and balance at all times.
- don't be fooled by illusions caused by groundspeed or ground track.
- use your knowledge of the effects of wind to your advantage.
- the closer one is to the ground, the more dramatic the effects of wind appear.

TURBULENCE

If the atmosphere in which we flew were always still, no pilot would have his microlight bounced around the sky. As it happens, our sky is almost always in motion. Some of this motion is smooth and some is quite abrupt or violent.
There are two types of turbulence Mechanical and Thermal (or convection).

Mechanical Turbulence

If you have ever watched the water in a shallow stream, swirl and bubble over rocks submerged or partly submerged in it, then you have seen a close approximation of the action of air flowing over similar objects on the earth's surface.
Unfortunately we cannot see the air, but we can make a fairly accurate guess of the degree and type of turbulence to be expected for a given situation. As the microlight flies into disturbed air, its flight path is affected accordingly.
Whenever possible, try to observe the effects of mechanical turbulence by watching smoke or the movement of thistle "fairy" seeds as the breeze passes over the landscape. Even in light winds you will be surprised at what movements in the air these indicators show.

In an open paddock with some obstacles in it (barn or row of trees etc) one can stand in the lee and feel the turbulent flow, or wind shadow.

An awareness of mechanical turbulence is important, especially as many microlight operations involve airstrips closely surrounded by turbulence producing objects and terrain, as opposed to the wide open space of big airports.

Let's look at some typical examples of mechanical turbulence.

Remember, any time the air is made to flow over or around an object, the airflow will be affected. Where the airflow is required to change direction abruptly, the flow will break up and become turbulent.

The extent and severity of the lift and sink in mechanical turbulence, increases sharply with increasing wind strength.

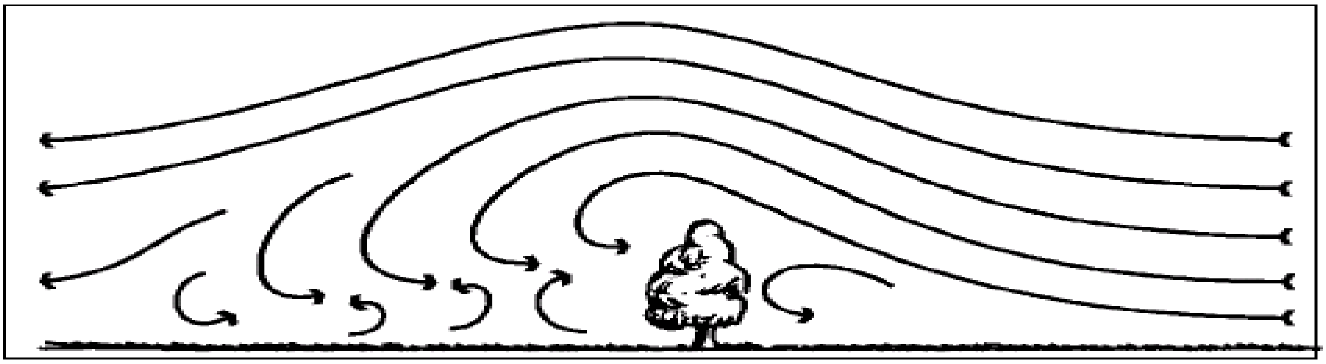

Fig. 69 Wind flow over a row of close thickly leafed trees.

Wind flowing over these trees (Fig. 69) will be forced to go over the top as not much air will be able to flow easily through. This will cause an abrupt change as the air rises over the row, and then behind will be an area of turbulent air as the flow breaks up. As a general rule allow at least 6 or 7 times the height of the trees downwind to be free of the turbulence in moderate winds.

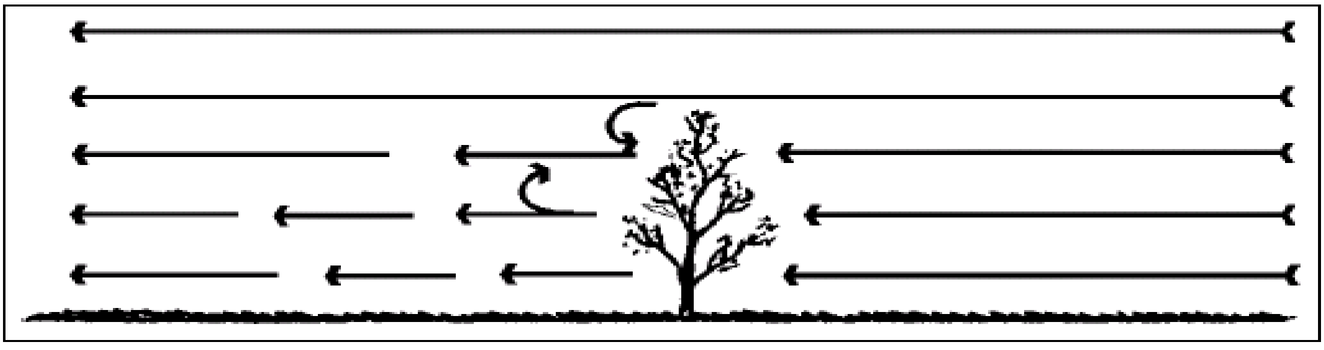

Fig. 70 Wind flow over a row of thinly leafed or less densely spaced trees.

If the trees are spaced apart or thinly leafed, then the turbulence may be reduced as a significant flow of air will be able to pass through the trees.

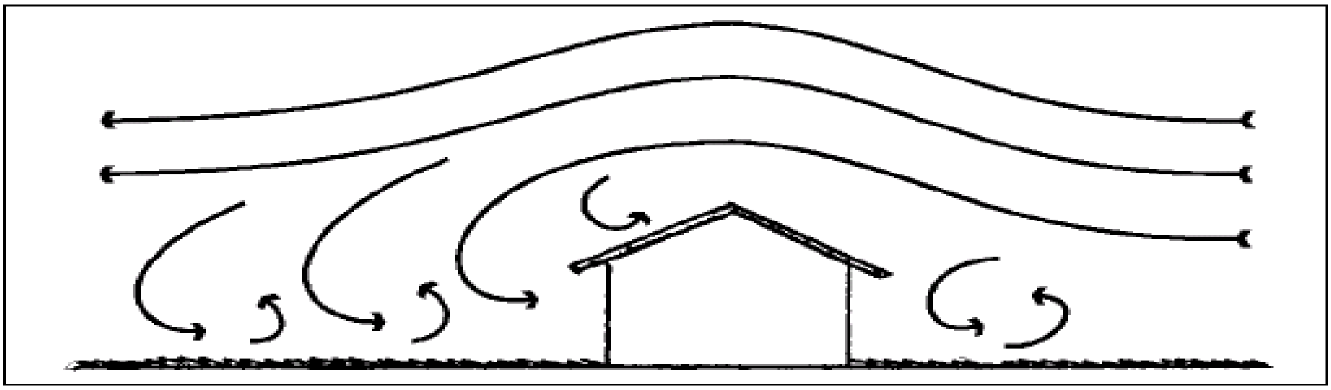

Fig. 71 Wind flow over building. This is much the same as over trees.

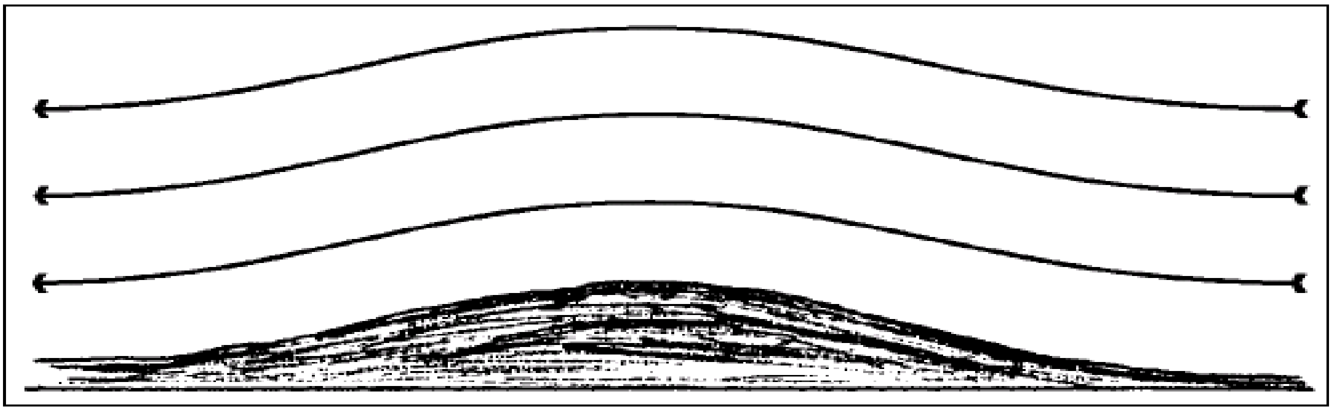

Fig. 72 Wind flow over terrain. Wind flow over smooth gentle hills may produce little or no turbulence, only lift upwind and sink down wind.

Effect of Wind Speed on Extent of Turbulence

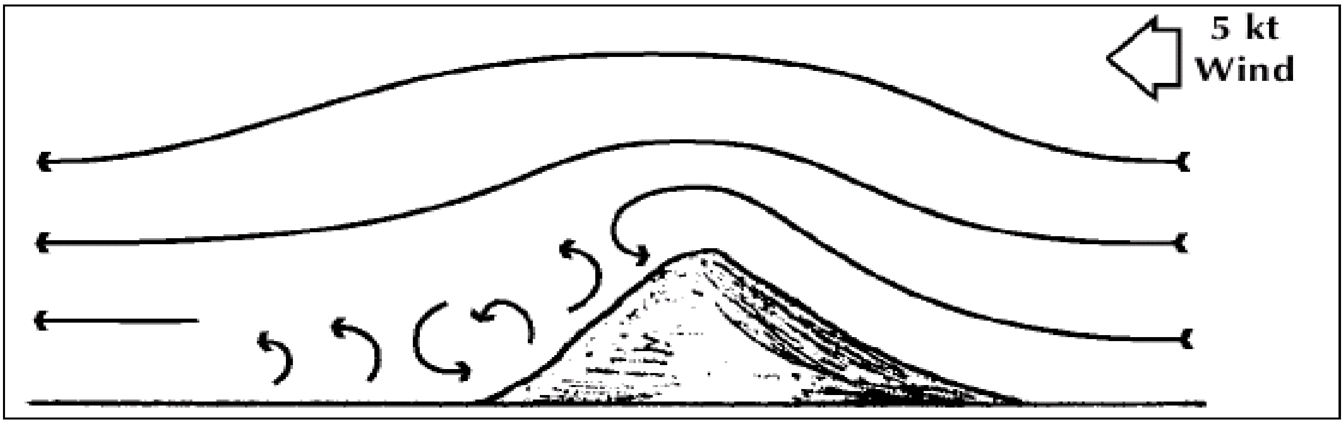

Fig. 73 Effect of 5 kt Wind.

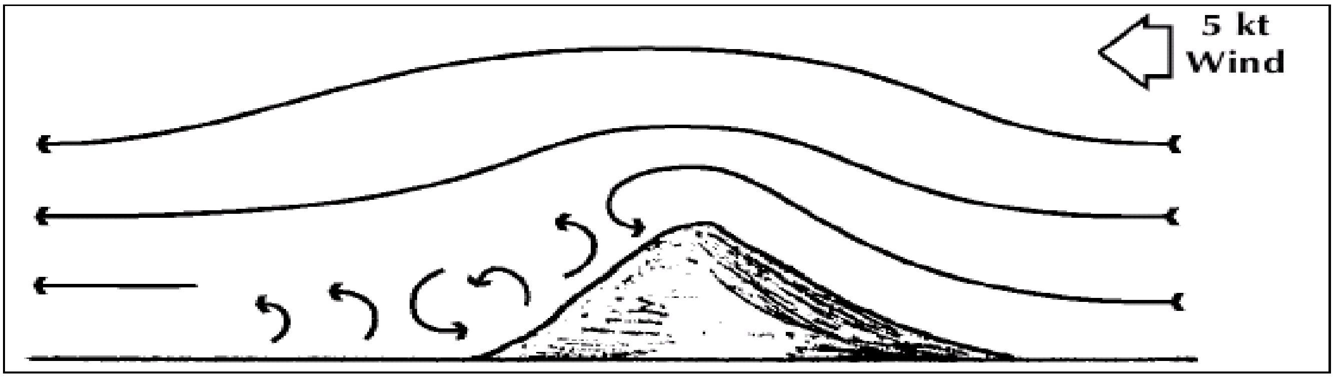

Fig. 74 Effect of 10 kt Wind.

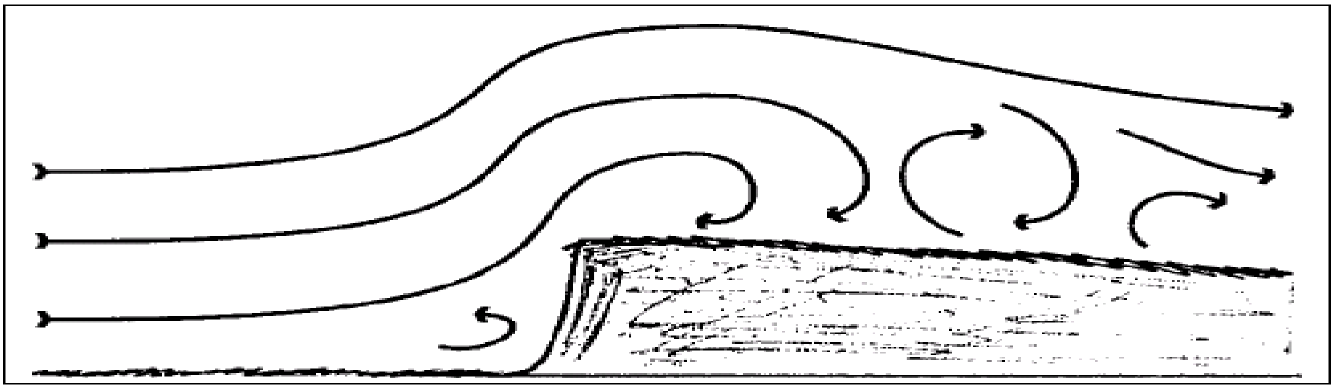

Fig. 75 At the base of a cliff there may be a turbulent area and almost certainly behind the lip of the cliff it will be very dangerous.

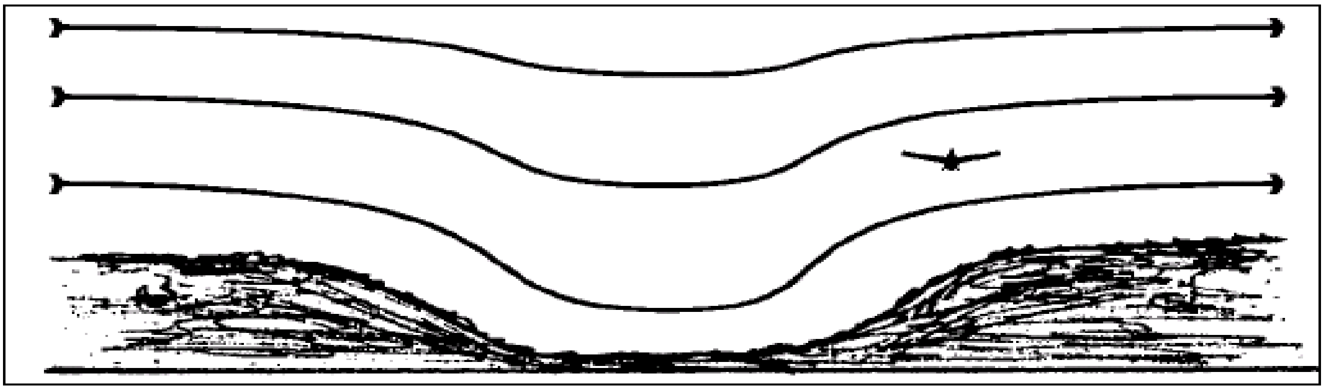

Fig. 76 When flying along a valley with the wind blowing across it, stay on the downwind side where the air will be smoother and rising.

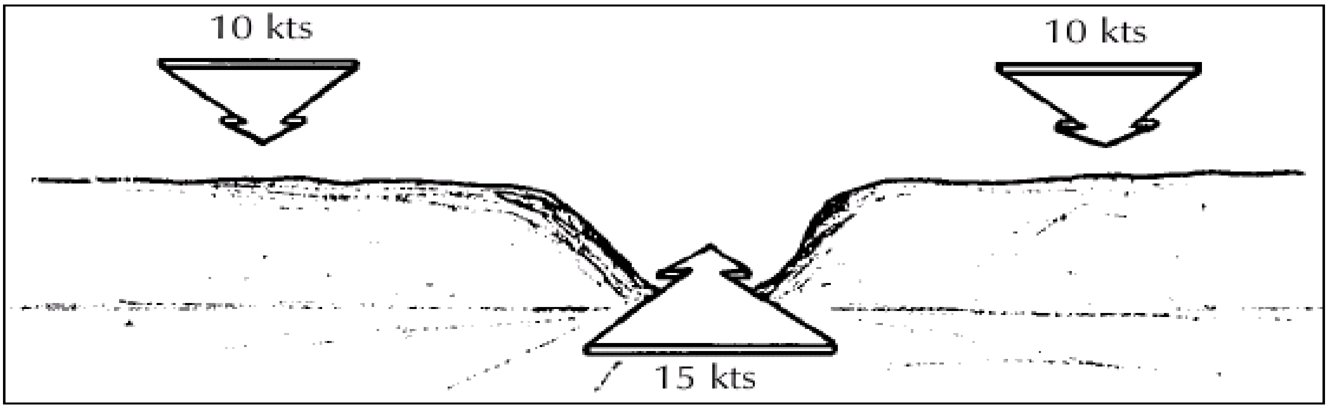

Fig. 77 Wind speed increases when flowing through gaps in ranges.

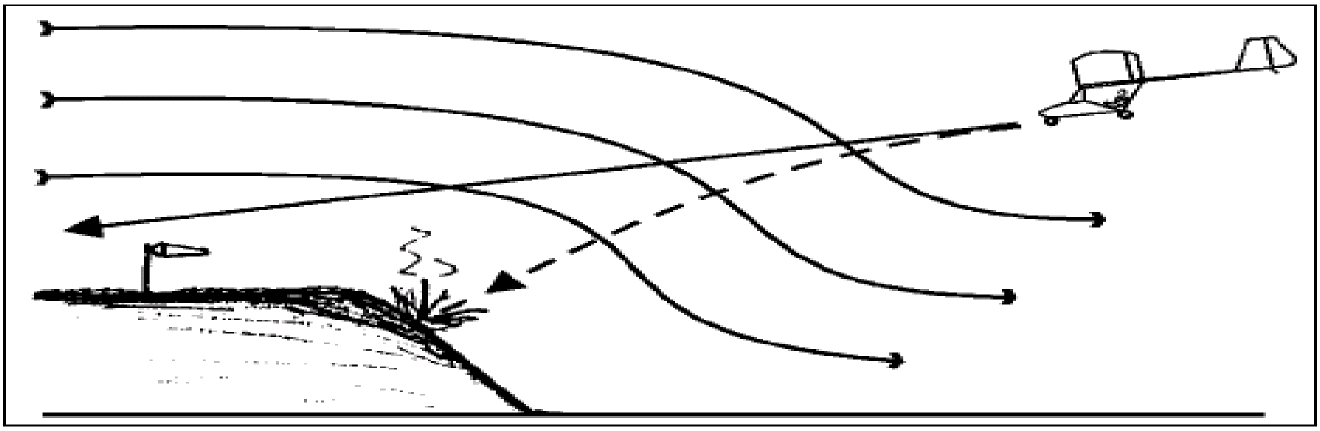

Fig. 78 With a drop of the landing end of a runway, there is likely to be sink which will affect the glide path.

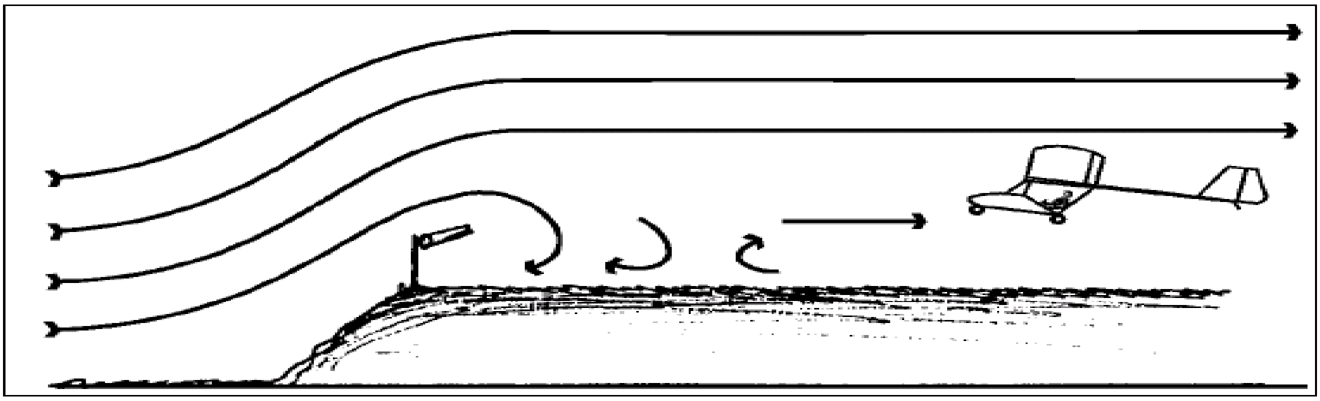

Fig. 79 Likewise, with a drop off the takeoff end of the runway there will be sudden lift and even turbulence back from the edge.

Flying into Lift and Sink

Flying into lift (rising air) momentarily increases the angle of attack of the wing as the relative airflow is changed. This will cause a drop in airspeed due to the increased drag of the higher angle of attack. If the lift is sufficient the microlight will rise.

Flying into sink (descending air) momentarily reduces the angle of attack of the wing as the relative flow is changed. This will cause an increase in airspeed due to the less drag of the smaller angle of attack. The microlight may descend.

When encountering lift or sink and the airspeed is altered, the microlight will try to return to its previously trimmed value.

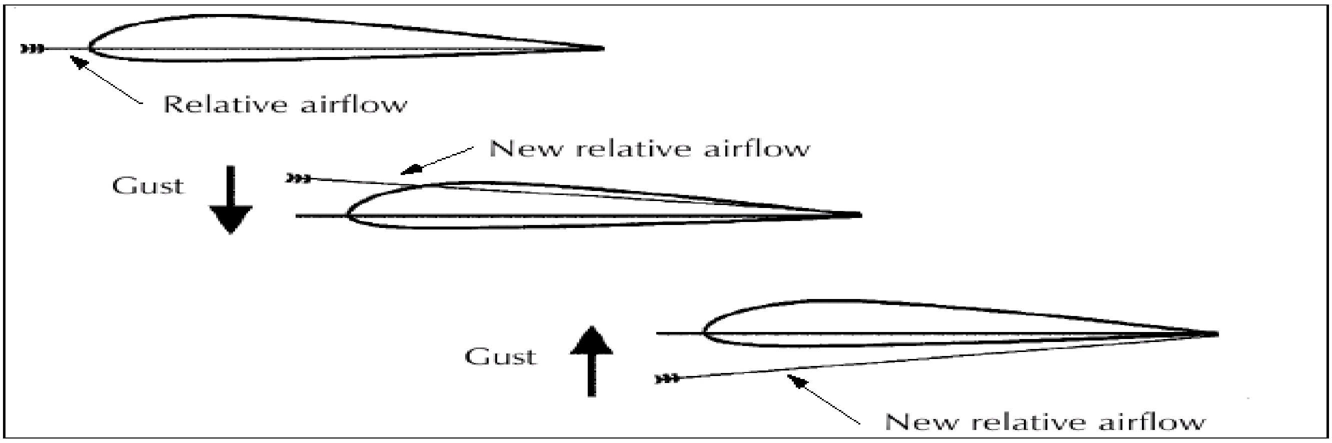

Fig. 80 These vertical gusts causing rapid changes in angle of attack, impose stress on the microlight airframe. The load factor alters.

Wind Shear/Gradient

Due to the friction the air experiences flowing over the surface of the earth, the wind speed near the ground is usually less than that at altitude. These effects are usually (but not always) small when the winds are light, but become greater when the winds are strong. Added to this is the effect of mechanical down draughts. Down draughts can cause a sudden decrease in the microlights rate of climb immediately after takeoff, or a sudden increase in the rate of the descent during the approach to landing.

The possibility of meeting such conditions creates a need for all pilots to be aware of the hazards associated with these variations in wind velocity during the takeoff and landing stages in particular.

Any variation of airflow velocity, whether it be horizontal or vertical, produces a shearing action between layers of air, hence the term "wind shear". The effects of wind gusts and associated turbulence can be appreciated fairly easily, but changes in the horizontal wind speed and/or direction will require more explanation. Lift is the force which overcomes weight and an aircraft obtains this lift from the angle of attack at which the wings are presented to the airflow and the speed at which it is flown. The higher the airspeed, the greater is the lift. Therefore, any sudden change in the wind speed or its direction relative to the aircraft will affect the lift being produced.

A microlight descending through layers of air where the wind speed is decreasing rapidly, will be penetrating a region of wind shear/gradient, the effect of which will temporarily lower the airspeed. Less lift will be produced and the microlight will descend more quickly.

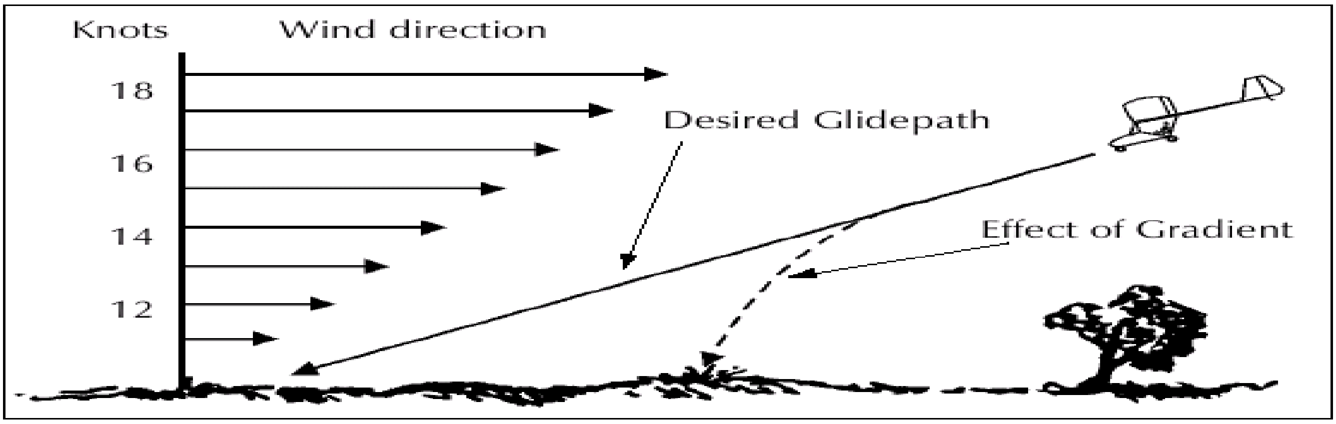

Fig. 81

When the gradient is gentle the pilot will have no trouble in lowering the nose of the microlight to regain its original airspeed, but if the wind gradient is rapid and pronounced he will need to act very quickly to readjust the microlights' airspeed, and also increase engine power to help arrest the descent.
Sometimes the effects of mechanical turbulence, thunderstorm activity, or an inversion, can create the effect shown in the illustration below.

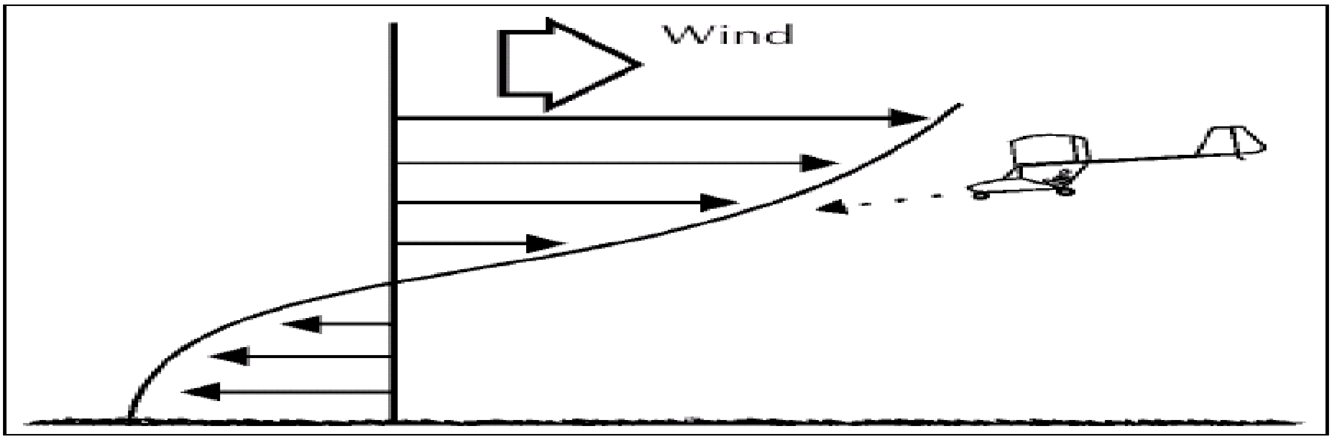

Fig. 82 In this case the wind direction has become temporarily reversed near the ground requiring very quick reactions from the pilot during the takeoff or landing phase.

Wind shear is a particularly common occurrence during thunderstorm activity, and can be met on any side of such an area. The wind shift line (or gust front) can precede a storm by 15-20 miles, consequently, when thunderstorms are within this distance wind shear hazards must be anticipated at any time.
A further note in relation to wind shear is that it is not necessarily associated with strong winds.
For example, when a temperature inversion exists, a common situation is for very light or zero wind to be present at the surface although winds just above the inversion layer may be moderate to strong.

Thermal or Convection Turbulence

This is caused by the heating of the earth's surface which in turn heats the air in contact with it, and causes convection currents which over land reach their maximum intensity about midafternoon. If the rising air is moist, convection cloud will form cumulus (Cu), strato cumulus (Sc), or possibly in very unstable conditions, cumulonimbus (Cb).
On days when these clouds are present expect to encounter both lift and sink associated with the convection process. In general, this lift and sink is fairly mild and the lift can even be used by a skilled pilot to enhance climb performance or even to sustain lift. However, when such thermal activity is vigorous the conditions can become very violent. The lift associated with the abovementioned clouds can be stronger than the microlight's ability to descend through it.
Thus, there can be a very real danger of being "sucked into" cloud, (discussed in meteorology) so as a general rule keep well clear of fast growing towering cumulus type clouds.
With the exception of thunderstorms or line squalls, the effects of turbulence are usually greatest near the surface or just below large cumulus clouds. These regions can normally be avoided during enroute flight. However, the altitude band in which microlights operate is somewhat restricted, and additional care will be needed when mountains or high hills have to be traversed.
In these regions, very strong up and down currents are often present and they can produce considerable hazards. Undertake such flights only in the most ideal conditions.

Summary

Knowledge of turbulence is vital to any pilot. Being able to distinguish safe conditions from dangerous conditions improves the safety of operations immensely. Even the experienced pilot will on occasion be surprised by unexpected turbulence, but the important thing is to be ready to take action and to try and ascertain the cause so as to learn from the event.
Don't just regard the sky as something you make holes in with your microlight. Respect it for the living moving thing it is, and strive to understand its ways and habits.

Wave

Under certain conditions the airflow over a range of hills or mountains can set up an unusual "wave" in the lee.
It is a similar action to water ripples in a stream immediately after flowing over a boulder or rock, except, of course, on a grand scale.

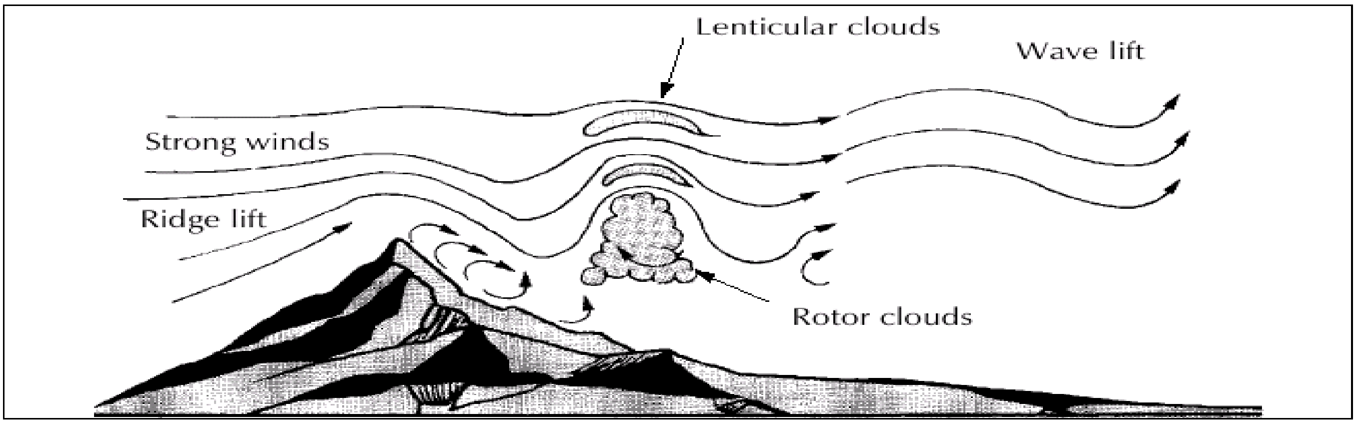

Fig. 83 Long lines of lenticular clouds perpendicular to the wind flow, which remain stationary, are the prime indication of the wave conditions.

Associated with wave are very strong lift and sink, and severe turbulence in the rotor areas which occur between each row of lenticulars. The rotor turbulence can be encountered at the altitudes microlights normally operate in, and has been responsible for inflight destruction of aircraft.
Generally speaking, the wind required for the wave system to form would normally preclude microlight operations. However, if the surface winds are not excessive but a wave system is present, expect higher upper winds and violent turbulence in the lee of the ranges.
In some parts of the country, wave formations are often enormous, with the wave systems extending many miles downwind and with lift and sink in regions sometimes reaching the 30,000ft mark! Microlights are not suited to tackling wave conditions. Sometimes, smaller localised wave systems can develop.

Wake Turbulence

The following has been reproduced from the February/March 1984 Flight Safety Magazine.
Although the discussion deals mainly with wake turbulence produced by aircraft of jet transport size, from a microlight pilot's point of view the wake from any other aircraft needs to be avoided.
Light wing loading, low speeds and often less than sharp control response (especially roll) make microlights more susceptible to wake turbulence.

Vortex Generation

Lift is generated by the creation of a pressure differential over the wing surface of an aircraft, the lower pressures being above the airfoil. This pressure difference induces a rolling motion in the airflow behind the aircraft, producing swirling air masses which trail downstream from the wing tips. As the rolling motion is completed, the wake develops into two counter-rotating, cylindrical vortices, the characteristics of which vary according to conditions, aircraft configuration and changes of airspeed. They may be described as a pair of horizontal tornadoes trailing behind the wingtips.
Wake vortex strength is directly related to lift generated, size of the airfoil and angle of attack of the airfoil, and is general y inversely proportional to the airspeed of the generating aircraft. The greater the weight of the aircraft (fixed or rotor wing) the more intense will be the wake. The longer and broader the airfoil the greater the area affected. Tangential velocities of up to 85 metres per second (166 kts) within the vortex core have been recorded in trials conducted with Boeing 747 and 727 aircraft.
The danger to light aircraft from wake turbulence stems from the fact that this rate of roll easily exceeds their control capabilities, particularly when the affected aircraft has a shorter wingspan than that of the generating aircraft. As an indication of how powerful wake vortices can be, the pilot of a Beech Bonanza approaching an airport in the US planned to pass above the altitude of an airliner that was on base leg for landing. At 1170ft AGL and indicating 160 MPH, the pilot heard a loud bang and felt a jolt. The control wheel jerked aft and the aircraft abruptly entered what the pilot

described as a wings level loop of some 35 seconds duration. After coming out of the upset manoeuvre he could not read his instruments because of severe vibration. After reducing power and airspeed, the vibration ceased and he completed a safe landing. Structural deformation was discovered on the right hand stabiliser.

The degree of danger associated with wake turbulence diminishes in direct proportion to the distance and time interval between the aircraft involved, and the height above ground at which it occurs. These factors directly affect the chances of recovery from an upset. Wake turbulence strength is likely to be at its peak when the generating aircraft is large, clean (flaps and landing gear retracted), and flying slowly, which suggests that a large aircraft in the holding configuration presents the greatest threat of wake turbulence.

Vortices generated near ground level typically last between one and two minutes, while those generated at higher altitudes can last as long as five minutes, leaving a trail of turbulent air several miles long.

Vortex Behaviour

The movement of these areas of violently disturbed air conforms to certain predictable patterns in most instances, enabling pilots to visualise the wake location and thus avoid the vortex core.

Vortices generated at altitude sink at a rate of 400-500 feet per minute initially, then gradually stabilise 900-1,000ft below the flight path of the generating aircraft. Eventually the vortices break up, the process being hastened by any atmospheric turbulence.

The cardinal rule for avoiding a wake turbulence encounter is to keep clear of the area behind and below a generating aircraft ahead, whether taking off, landing or flying en route. All precautionary techniques are based on that principle.

Pilots should be particularly alert to the possibility of wake turbulence in calm conditions and in situations where the vortices could:

- Remain in the touch down area.
- Drift across from an aircraft operating on a nearby runway.
- Sink into the flight path of an aircraft flying at a lower altitude.

Other rules of thumb are:

- Be particularly cautious when a light quartering tail wind exists on approach and a larger aircraft has already landed.
- Use the full length of runway available to help to keep the climb out path above that of preceding aircraft.
- Be alert for wake turbulence when a preceding large aircraft has executed go-around, or when your rotation point will be further along the runway than that of a preceding large aircraft.
- If you are in doubt about the possible existence of wake turbulence, delay the takeoff or execute a go-around

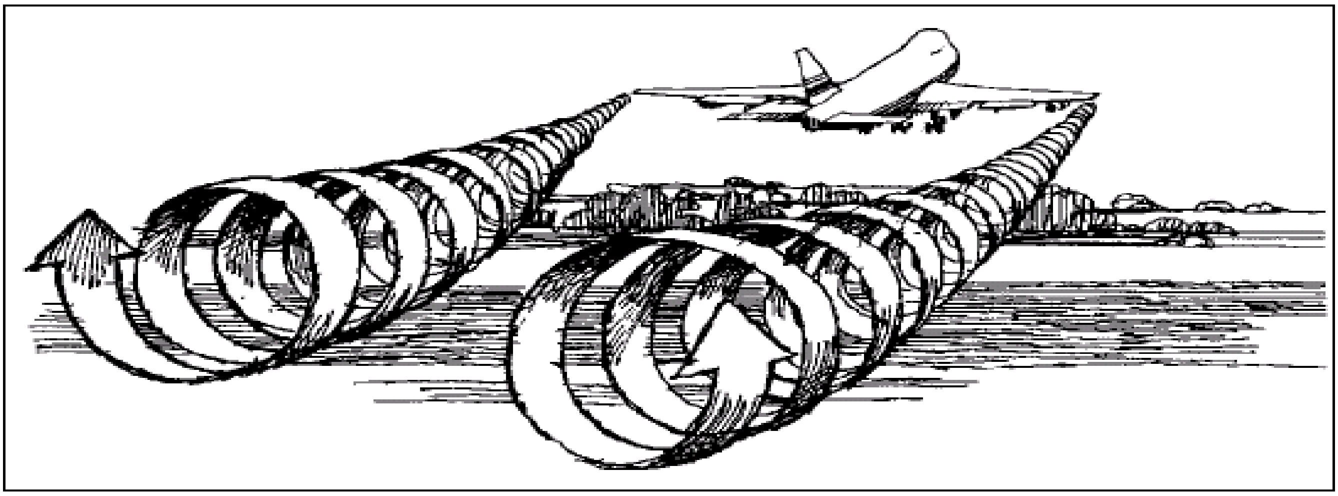

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Fig. 84 Wake generated behind a Boeing 747 on takeoff.

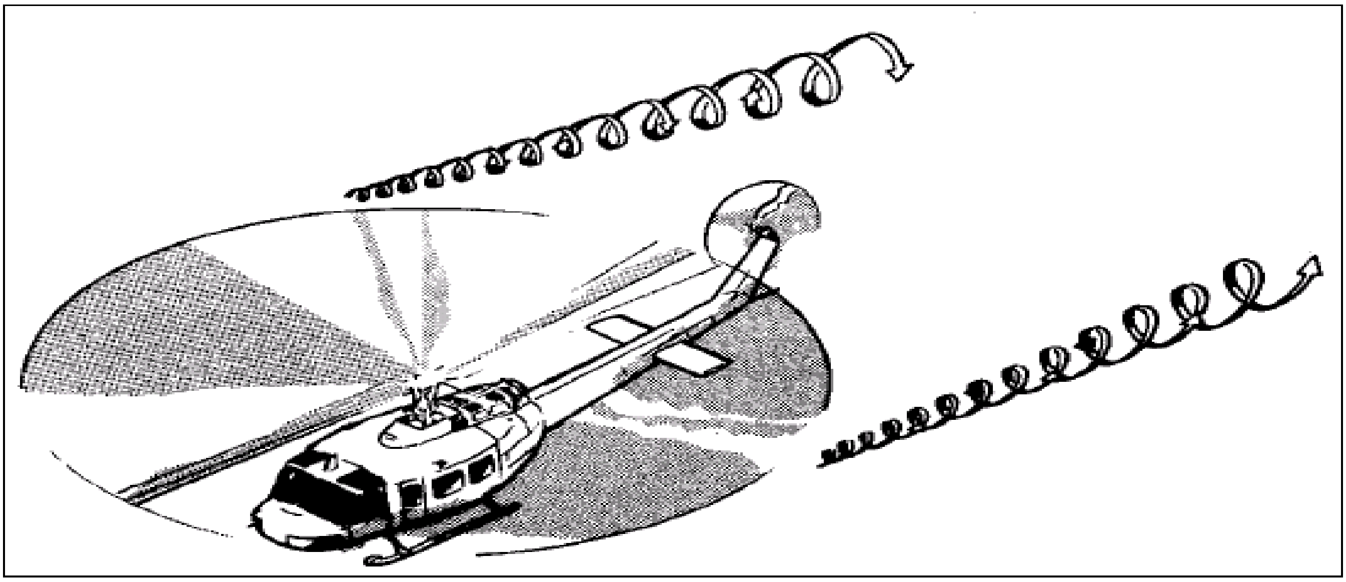


Fig. 85 Wake generated by a helicopter in flight is similar to that of a fixed wing aircraft.

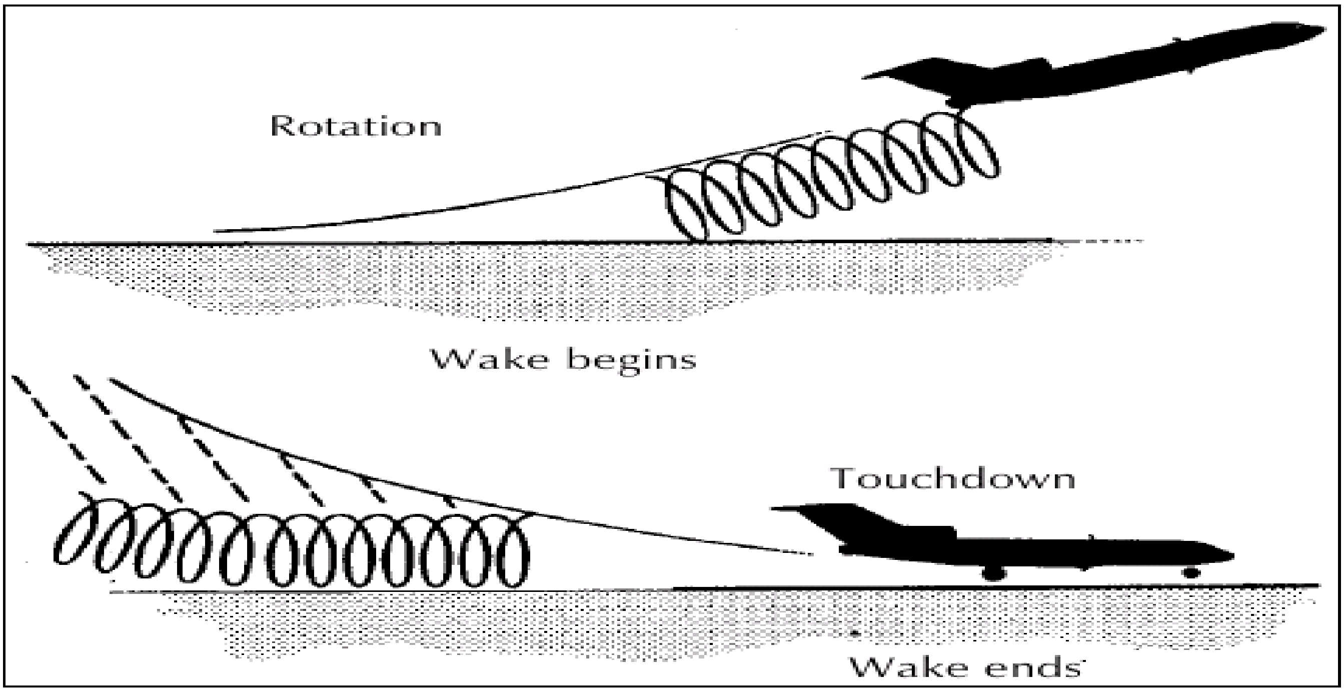


Fig. 86 On nose-wheel aircraft wake vortices are generated at the point of rotation for takeoff.

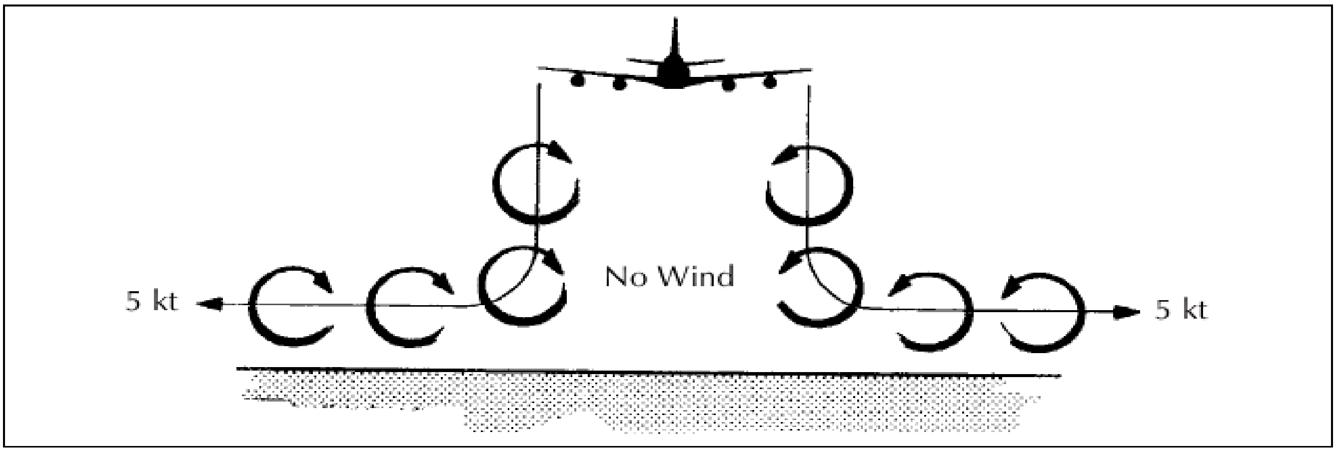


Fig. 87 In nil wind conditions these vortices settle to the ground and then move outwards at a speed of about 5 knots.

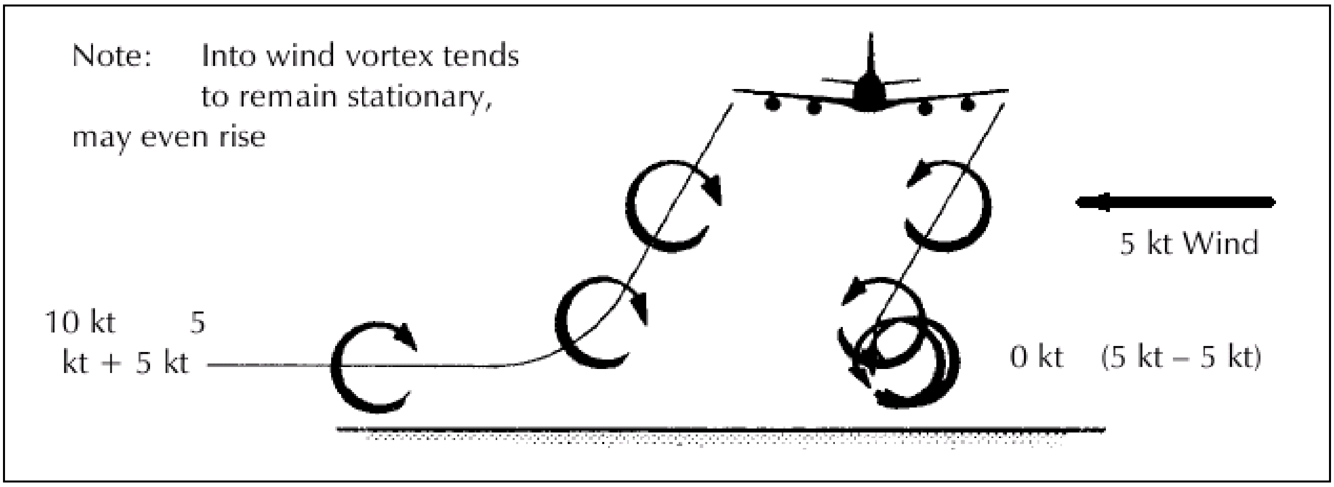


Fig. 88 If a light crosswind is present, it will arrest or impede the outward movement of the upwind vortex while assisting the movement of the downwind vortex.

6. Law

AVIATION LAW FOR THE MICROLIGHT PILOT

Introduction

In this section we will cover the most common rules that affect microlight pilots. Microlight rules are embodied in the MCAA rules. MCAA rules Part 12, 91, 103, 149, all have in them rules which are applicable to microlight pilots. X-TEAM is an Approved Organisation under Part 149 and the majority of microlight rules are in Part 103. Part 91 covers the General Operating rules which all aircraft operate under. Part 12 is the accident and defect reporting rule.
The MCAA uses a number of other documents to convey further information and elaborate on the rules of flying like as Advisory Circulars (ACs) and Forms, etc.
AIP - Mongolia Aeronautical Information Publication. These are used to cover orders, procedures and information. The AIP is split into four volumes:

- Volume 1 is the **Planning Manual** which provides comprehensive information of rules and operations, etc for Mongolia. It is not essential for microlight flying.
- Volumes 2 and 3 are about **IFR flight** and not relevant to microlight flying.
- Volume 4 is the **Visual Flight Guide** and is important to microlight flying. It contains operational information, aerodrome charts, and details of procedures required for operations under VFR for land aerodromes. This document is to be used by the microlight pilot flying in and out of licensed aerodromes.

The **AIP Supplement** contains information which is of a temporary nature not urgent enough to warrant promulgation by NOTAM (eg airshows, temporary works or procedures), or that contains extensive text or graphics and cannot be clearly promulgated by NOTAM. AIP Supplements are distributed by post to holders of any of the AIP volumes, and available off the AIP website.
NOTAMs (Notices to Airmen) are used to promulgate temporary changes to operationally significant information that requires immediate dissemination. NOTAM are issued via the AFTN, and are available via the Air Traffic Control system and off the IFIS website.
Aeronautical Charts A number of Aeronautical Charts are published including Enroute Charts, Area Charts, etc. The charts essential for visual navigation flights around Mongolia are the **VNC Visual Navigation Charts**. A description of all aeronautical charts is given in the AIP MAP Section. Charts are available from the Airways AIP shop website.

Responsibility of the Pilot in Command

The pilot in command is responsible to ensure that the microlight has valid documentation, is properly preflighted (i.e. not overloaded or badly loaded), has sufficient fuel and oil and the microlight is safe for the flight.
The pilot shall make final decisions, is responsible for reporting defects (if the microlight is not theirs) and is ultimately responsible if any rules are broken.
In two seaters where two licensed pilots are flying, one must always be nominated pilot in command.

Drink and Drugs

A "no-no" need any more be said! If a pilot is impaired in any way, he should not be flying.
If on any medication, consult your doctor as to effects before flying.

Operation of Controls

Only licensed pilots (including authorised students) are allowed to operate controls. This includes ground taxiing. The only exception to this is in two seaters where there is an instructor onboard and giving instruction.

Dropping of Articles

Any person dropping anything from a microlight is responsible for the article and where it may land. No article may be dropped that creates a hazardous situation.

Carriage of Persons on an Aircraft

No person shall be carried on a microlight unless they are located in an area specifically designed for that purpose, and the pilot in command has a passenger rating.

Classification of Operations

Private - not used for hire or reward. Microlight flying is a private operation. Instruction is considered a private operation as the student is considered "crew" not passenger. Where a passenger is paying for a the operation must be carried out under MCAA Part 115.

Documents

Al flight crew shall keep a logbook. These are available through X-TEAM, affiliated clubs, or the MMCAA website. Permanent entries shall be made within 48 hours of the flight and the logbook shall be kept at least six months after the last flight.

If a radio is used on the microlight then a radio license is required to be kept with the radio.

A MCAA flight permit shall be obtained for class II microlights. This flight permit is valid for 12 months and is renewable after a survey by an Inspection Authority Holder. A flight permit will only be given where the microlight has type acceptance and has been inspected by an approved person. Registration marks must be affixed in accordance with MCAA Part 47.

Test Flying

Approval must be held from X-TEAM before a person may undertake a test flight in a microlight. All Senior Instructors are deemed to be Test Pilots.

Instruments

An altimeter, compass, and airspeed indicator are the minimum instrumentation required for all flights.

Emergency Locater Transmitters (ELTs)

Any microlight on a flight greater than 10NM from the point of departure must carry an ELT (406MHz). The ELT may be permanently fitted to the aircraft, or be a Personal Locater Beacon (PLB) carried by the pilot or passenger. The ELT/PLB must be registered with the Rescue Coordination Centre (RCC) in Mongolia including contact details of the aircraft operator. In the case of a club aircraft where the aircraft and PLB are shared among many users, it is important that a register of the person flying the aircraft and their mobile phone number is available to the person whose contact details are registered with the RCC.

Planning of Flights

The pilot in command must plan his flights to ensure safety and this must include:

- the checking of meteorological conditions.
- the checking of NOTAMS that may affect the flight
- the checking of radio facilities if required.
- the checking of any licensed aerodrome procedures to ensure microlight flight can be conducted safely and include gaining the necessary approvals.

No flight is permitted within 3NM of a licensed aerodrome unless approval is gained from a Senior Microlight Instructor, or a Category "A", or "B" Instructor. Where flight in to or out of an attended aerodrome is contemplated, clearances must be obtained from the Air Traffic Services Unit at the aerodrome.

- The pilot shall satisfy himself as far as possible as to the safety of landing zones intended for use.
- He shall check air traffic rules and procedures applicable to the flight (i.e. entry into controlled airspace).

Minimum Safe Heights

No flying over crowds is permitted. The rule states that you must not fly over a congested area. In addition, unless taking off or landing, no flight shall be conducted at less than 500 feet above ground level. The only exemptions to this rule are if in a designated low flying area with an instructor. If low flying is required as an operational requirement, approval must be gained from X-TEAM.

VFR Flight Plan

Each pilot-in-command of an aircraft shall submit a flight plan to an appropriate ATS unit prior to the start of each flight under VFR:

- that proceeds more than 50nm from shore; or
- if the pilot in command requires an alerting service.

Note: In controlled airspace ATC can authorize special VFR flights when in a CTR with a cloud base down to 600ft and a visibility of 1500 metres. Special clearances are required in other CTAs to allow operation up to the cloud base.

Cross Country Flight

All microlight flight is VFR flight and must be visually navigated. Prior to undertaking a cross country flight or any flight during which it is proposed to proceed beyond gliding distance of land in a microlight, the pilot is recommended to advise a responsible person of their intentions and specify any action to be taken by that person if they do not receive notification of the safe termination of the flight. Alternatively a VFR FLIGHT PLAN may be filed with ATC.

When flight is conducted beyond gliding distance of land, a life jacket shall be worn.

Appropriate charts shall be carried on all cross country flights.

Fuel and Oil

Sufficient fuel and oil shall be carried for the safe conduct of the flight including allowances for any change in meteorological conditions and/or delays, plus a reserve for contingencies and landing at an alternative site.

General Operations

Al flight shall be conducted clear of cloud and beneath the ceiling, i.e. beneath the base of the lowest cloud covering more than half the sky.

All circuits should be flown at a minimum of 500ft AGL or at the circuit height specified on landing charts for the appropriate aerodrome. The first turn after takeoff first turn shall be made at 500ft AGL unless there is a requirement to turn earlier due to obstacles, but nevertheless it must be at a safe height.

No flight at night is permitted. That means between Evening Civil Twilight (ECT) and Morning Civil Twilight (MCT).

All flight conducted by a novice pilot or student pilot shall be under the supervision of an Instructor.

Right of Way Rules

If you have right of way you are expected to maintain your current flight heading and speed to allow the conflicting traffic to avoid you. If you have to avoid traffic, ensure you pass well clear. Never assume the other aircraft has seen you.

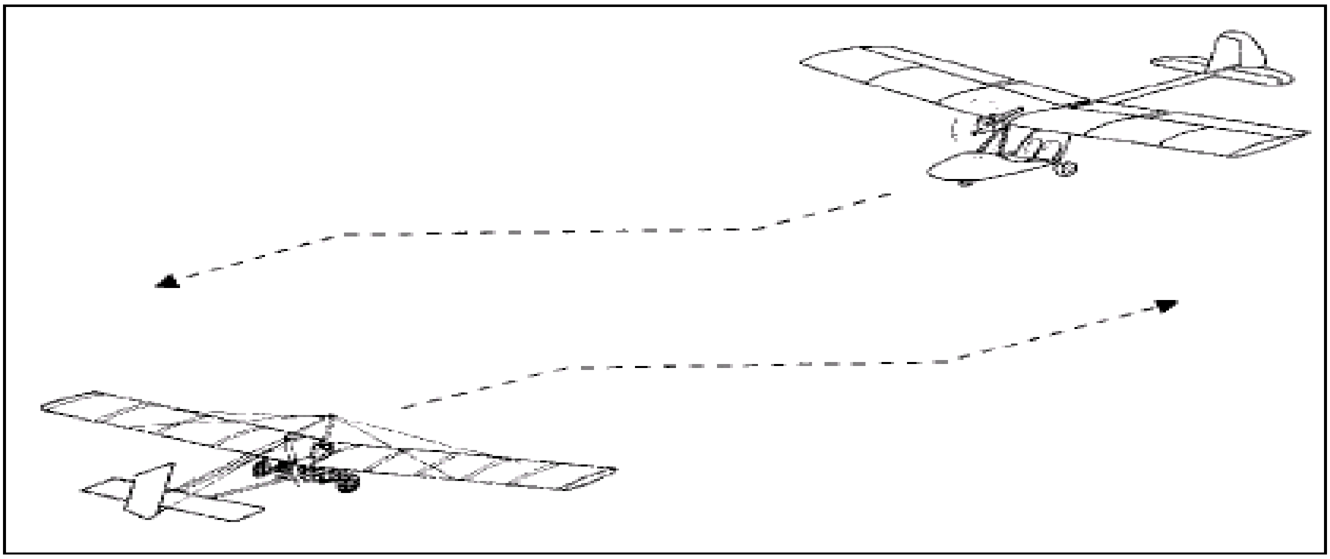


Fig. 120 Approaching head on Each aircraft turns to the right.

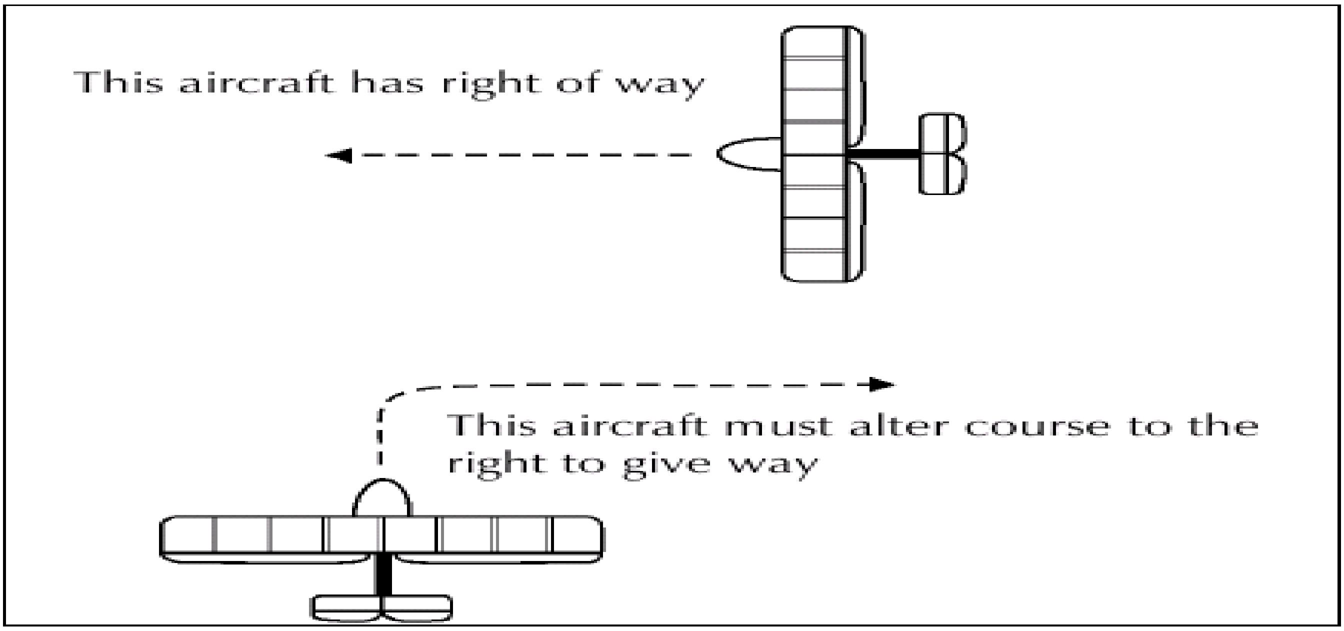


Fig. 121 Converging - The right hand rule applies except that power driven aircraft give way to gliders or aircraft towing objects.

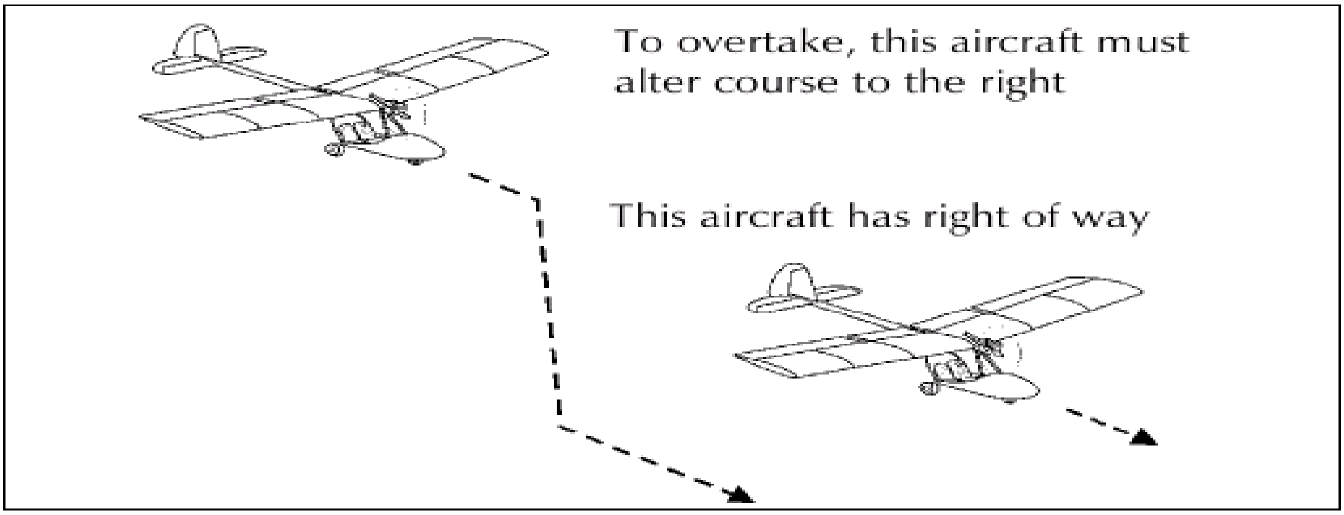


Fig. 122 Overtaking - The slower aircraft has the right of way. If overtaking, alter course to the right.

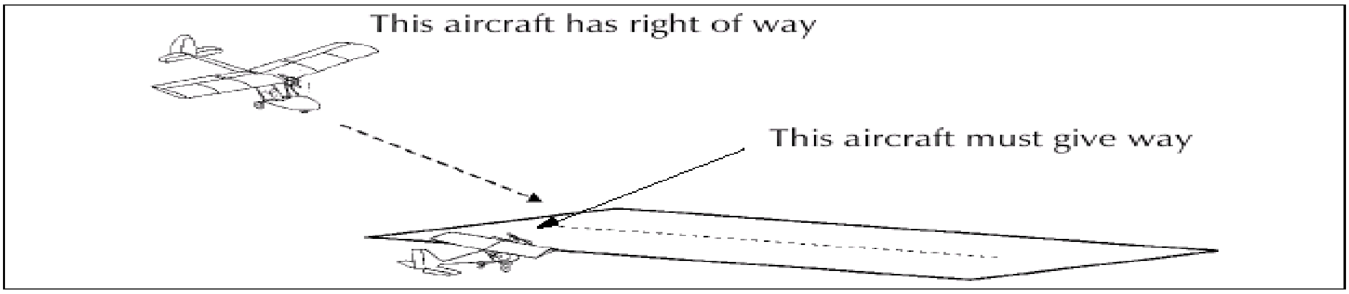


Fig. 123 Landing Any aircraft manoeuvring on the ground must give way to landing aircraft of aircraft on final approach.

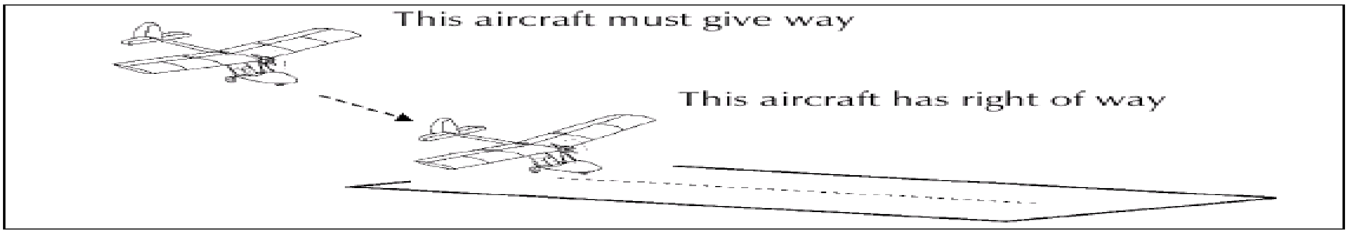


Fig. 124 If two aircraft are landing at the same time the lower aircraft has right of way.

Aircraft when landing must land to the right of any aircraft which has just landed or is about to land or which is taking off or about to take off.
An aircraft when landing must land on the left to leave reasonable room to the right for other aircraft.
Turn left after landing, unless instructed otherwise.
Everyone must give way to aircraft making an emergency landing.
Takeoff no takeoffs are permitted when there is a danger of collision.

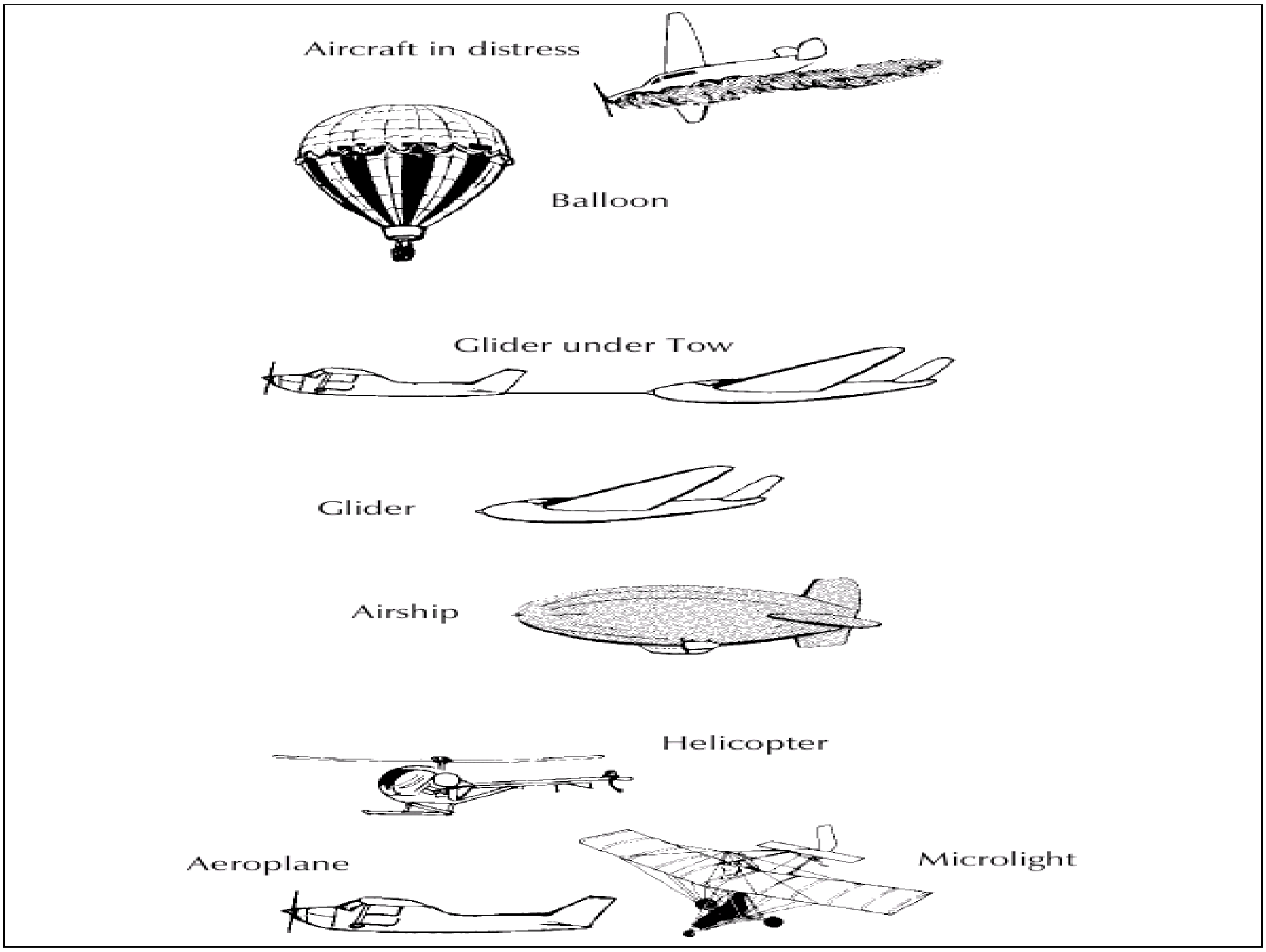


Fig. 125 Aircraft priority relative to manoeuvrability.

Accidents

A noticeable accident is one where a person is killed or seriously injured or the microlight suffers serious damage or structural failure that adversely affects its structural strength, performance, or flight characteristics and requires major repair or component replacement. If a microlight is overdue on a flight an accident is deemed to have occurred.

The pilot in command, or, if he is incapacitated, the operator of the microlight shall notify the Civil Aviation Authority by the quickest means possible, and, if damage to a third party person or property occurs, the police must also be informed. Air Traffic Service Units are available to assist in the reporting of accidents. The MCAA website has reporting accidents, occurrences and defects.

Notification should include the following:

- Microlight Type and Registration.
- Name of owner, operator and pilot and any passenger.
- Date and time of accident.
- Point of departure, intended landing point and last known position.
- Any injuries or death and/or damage including third parties.
- Details of the accident.

From the time of accident the microlight is in the custody of the MCAA, no person shall have access to the microlight or shall remove the microlight or any part from the accident site without the approval of the MCAA except to:

- Remove persons or animals from the accident site.
- To remove the microlight to prevent obstruction to the public or to air traffic or other transport.
- The microlight can be brought to a place of safety if wrecked on water.

Anything that is removed from the aircraft should only be as far away from the aircraft as to ensure its safety. The Air Accident Inspectors have total control of the accident site. After the investigation is concluded al held wreckage must be returned to the owner.

TYPE RATINGS

Microlights are classified into five groups.

Group A	Weight Shift	Controlled by lateral and longitudinal movement of the pilots body in relation to a control bar or A frame rigidly attached to the wing.
Group B	Three Axis Control	Control about the lateral axis is achieved by elevator or canard or sling, and about the longitudinal axis by ailerons, differential spoilers or wing warping and about the normal axis by rudder. Microlights in this category shall be stick and rudder control.
Group H	Microlight Helicopters	Conventional helicopter controls.
Group P	Powered Parachutes	Control is by pulling on the steering risers connected to the chute and throttle operation.
Group R	Rotorcraft or Gyrocopters	Control is through the cyclic to the rotor head. The rotor is free running with forward thrust provided by a separate propeller.

A **type rating** is required for each separate aircraft type (manufacturer and model) in the above groups. This includes aircraft of the same type but which have a different engine or propeller operation.

After demonstrating competence to your instructor, he/she may endorse your logbook accordingly. During the course of your microlight flying, you will probably have the opportunity to pilot microlights of various types and configurations.

When such an opportunity arises there are several points to consider. It is important to remember that the handling and performance of the various types can differ markedly. It is not acceptable to merely jump in and fly a new type without a type rating.

Wherever possible, observe the microlight flying, especially landing and taking off. In this way you can get an appreciation of what to expect in the way of ground run and performance.

Talk to your instructor about handling the aircraft, especially any noteworthy aspects such as what to expect at the stall onset etc. Make sure you know thoroughly:

- Stall speed.
- Liftoff speed.
- Climb speed.
- Cruise speed.
- Approach speed.
- Takeoff, climb, cruise and descent R.P.M.
- Vne and manoeuvring speeds.
- Weight and balance figures.
- Know the fuel quantity on board and consumption rate, as well as being familiar with the fuel cocks etc.
- Ask to be shown a preflight of the microlight. Ask about any unusual features you note.
- Get strapped in and familiarise yourself with the operation and location of all controls. It does not hurt to spend time on the ground in the cockpit until you feel happy with the layout.
- Note the attitude of the aircraft as it sits on the ground and visualise the landing attitude.
- If you are going to be flying a microlight employing a different control method, make sure you understand just how it works. Get it straight in your mind. Unless you are comfortable with the idea, you may not be ready.
- Your first solo flight in a new microlight should be made in good weather conditions. You don't want to have to cope with a strong crosswind for example. Furthermore, the field used should be big enough to provide a comfortable margin for both takeoff and landing.

The simple preparations above should help to make a type conversion easier and safer. Strangely, it is often the experienced pilot of other types who leaps into a microlight for the first time who gets into trouble. No matter what your flying experience or background, respect the microlight and listen to the advice of those who know the aircraft.

Law and the Microlight Instructor

Requirements for Issue of the **Instructor** rating are:

- Be the holder of an advanced pilot certificate.
- Demonstrate to a X-TEAM Testing Officer the ability to give ground instruction and ability to fly, within the group ratings for which he has ratings, all exercises being outlined in the X-TEAM procedures manual.
- Be recommended by his club.
- Pass an oral exam on VFR Operations, Principles of Flight, Preparation and Operation of Microlights and Micrometeorology as in the X-TEAM procedures manual.
- Either have 100 hours microlight time including 10 hours cross-country time or 100 hours total flight time in aircraft of which 50 must be in a microlight with 10 hours cross-country. (Where the applicant has considerable aviation experience special conditions apply.)
- Where the applicant has considerable aviation experience these requirements may be reduced. If a current A, B, or C Instructor Aeroplane, the pilot shall demonstrate competence to a Senior Microlight Instructor. If having previously held a Cat A, B, or C Instructor licence then 15 hours of microlight flight time is required before supervising microlight operations including cross-country No. 5 in the X-TEAM procedures manual.
- Be a financial member of X-TEAM.
- Renewal - A check must be completed with a X-TEAM Testing Officer in the last 12 months and a current medical is required.
- Recent Experience - The privileges of an instructor shall not be exercised unless he has carried out three takeoffs and landings in the last 90 days.

- Privileges - Give ground and flight instruction and authorise solo flight by the holder of a novice pilot certificate.

Only **Senior Instructors** may perform flight tests and send applicants on their first solo. Instructors are considered trainee and must liaise with Senior Instructors.

Water Operations

A water rating is required to operate a microlight aircraft from the water. Contact an appropriately qualified instructor, as there are different piloting techniques to be learnt when operating from water because of:
The inherent dangers of water operations. These include:

- Extra Preflight Considerations e.g. water in the floats and hull, corrosion due to salt water and extra stress on the airframe.
- Take off and Landing techniques.
- Taxiing considerations (lack of low speed control).
- Weather cocking tendencies.
- Glassy water operations.
- Wind and water current assessment.
- Emergency procedures.

The variety of types and combinations of water aircraft either Trikes or 3 Axis, with any of the following:

- Floats,
- Hulls,
- Amphibious,
- Air Dinghy.

A microlight operating from water is bound by the same regulations as a boat and therefore the pilot must be conversant with:

- General Harbour Regulations,
- Water Recreation Regulations,
- Rules for the Prevention of Collision at Sea.

It is possible to modify most microlights for water operations providing that the modification criteria have been followed. Most water aircraft are:

- heavier,
- have greater keel surfaces,
- greater frontal area (more drag),
- lower centre of drag.

This combination gives the aircraft a cumbersome feel when compared to its land counterpart. A training guide for water operations is available from X-TEAM at the current address.

Flight Certificates: Requirements for issue

Novice

- Medical Declaration.

Intermediate

- Novice Pilot certificate
- At least 25 hours flight time.
- Pass exam on Law, Nav., Met., and Technical Knowledge, (Rotorcraft and Helicopter where applicable).
- Demonstrate knowledge and ability and perform a flight test.
- If a PPL, demonstrate competence to a Senior Instructor.

Advanced Local

- Completed Advanced Local cross-country requirements.
- At least 40 hours flight time.
- Demonstrate knowledge and ability to conduct flight manoeuvres.

Advanced National

- Completed Advanced National cross-country requirements.

Passenger rating

- An endorsement to carry a passenger is available to Advanced pilots when the applicant has 45 hours flight time including 35 hours Pilot in Command and has demonstrated competence to a Senior Instructor.

Note: the difference between Advanced Local and National cross-country flight requirements is in the cross-country syllabus.

Recent Experience

Novice

- No solo until basic exercises completed. Continue under Instruction.

Intermediate, Advanced Local and Advanced National

- Three takeoffs and landings every 90 days.

Privileges

Novice

- PIC under instructor supervision for purposes of increasing skills or requalifying for expired licence.

Intermediate

- Limited to 10NM of the takeoff point.

Advanced Local

- Up to 50NM from base airfield
- If flying within 5km of a licensed aerodrome, must be briefed by an Instructor.
- Beyond 50NM all flights shall be briefed and authorised by an Instructor

Advanced National

- Unlimited

Medical certificates are valid for up to four years if under 40, two years if over 40, or as specified on the certificate. If there is a medical condition, the Doctor may specify a shorter time and must indicate whether the applicant can carry passengers.

7. Airspace

To facilitate safe, orderly use of airspace there are two internationally agreed sets of flight rules (**VFR**/Visual Flight Rules and **IFR**/Instrument Flight Rules)– to which all airspace users must adhere – plus several classes of airspace in which aircraft may operate to take advantage of the implied safety within those airspaces.

Controlled airspace is monitored and most traffic is directed, to varying extents, by ground-based air traffic control [ATC] specialists; and air routes are designated by ground based radio navigation aids. Air Traffic Services [ATS] include a flight information service [FIS] to traffic in the Class G airspace; an alerting service; an air traffic advisory service; and the ATC service within controlled airspace. ATS is provided by the personnel of Airways Corporation of MGL, using the VHF radio communications networks.

Uncontrolled airspace is not supervised or controlled- pilots must operate on a **see and be seen** basis following the Visual Flight Rules.

CAA airspace publications

Two useful CAA documents on airspace are:

- CAA GAP Airspace booklet
- CAA Airspace poster

Controlled airspace

Most controlled airspace exists between a lower level, for example 3500 feet amsl and some upper level, for example 9500 feet amsl – or FL95 – and is designated as a **Control Area [CTA]**.

Controlled airspace surrounding a civil or military aerodrome with a manned Air Traffic Control tower is a **Control Zone [CTR]** and starts at ground level and is stepped up to the lower limit of the overlying CTA. The steps provide the airspace for the airport approach and departure paths.

Handy hint

- A Control **Area** has its lower level up in the **air**
- A Control **Zone** goes all the way to the end of the alphabet (**Z**) and all the way to **ground**.

Three of the International Civil Aviation Organisation [ICAO] controlled airspace classes are used in Mongolia; A,C, and D.

Class A airspace is high level en-route airspace, covering most airspace above 9500 AMSL and stepping down where needed to cover main routes and approach/departure sectors. IFR only, radio required, transponder mandatory, clearance required prior to entry.

Class C airspace surrounds major airports starting at ground level (CTRs) and stepped up into mid-level Class C (CTAs) or the high level Class A airspace.

Class D airspace surrounds smaller regional airports with ATS services. The airspace starts at the surface and is stepped up into Class C approach/departure airspace. Mixed IFR/VFR, radio required, usually transponder mandatory, clearance required prior to entry.

Controlled Airspace

Class A	**Class C**	**Class D**
Upper airspace	Major airports, approach & departure lanes	Regional airports, approach and departure lanes
IFR only	IFR/VFR	IFR/VFR
Radio required	Radio required	Radio required
Clearance required	**Clearance required**	**Clearance required**
Transponder mandatory	Transponder mandatory	ATS discretion
IFR/IFR separation	IFR/VFR separation	IFR/VFR separation
	IFR/VFR traffic information	IFR/VFR traffic information
	5km visibility	5km visibility
	2km/500 ft from cloud (CTR) 2km/1000ft (CTA)	2km/500 ft from cloud (CTR) 2km/1000ft (CTA)
	250kts	250kts

Most controlled airspace is designated **TM Transponder mandatory**. Transponder equipped aircraft should be transmitting on Mode C (altitude) and code 1200 (general aviation). Non-transponder aircraft may be permitted entry at ATC discretion- either by prior arrangement or by advising **negative transponder** on requesting clearance to enter.

Class G airspace

All airspace which is not promulgated as class A, C or D is designated Class G and open without restriction for flight at or below the lower level of any airspace above. Some controlled airspace may have a Class G **VFR Transit Lane** providing a low level lane undercutting that airspace to facilitate transit or operations without reference to ATC.

Class G Airspace

Above 3000 AMSL or 1000 AGL	**Below 3000 AMSL or 1000 AGL**
5km visibility	5km visibility
2km/1000ft from cloud	clear of cloud & in sight of surface
below 10,000ft- 250kts	below 10,000ft- 250kts

To maintain safe separation at airfields in G airspace pilots are required to exercise 'see and avoid' techniques supplemented by VHF monitoring and broadcasting procedures designed to maintain traffic awareness and to manage circuit priorities, where appropriate, in the vicinity of such airfields.
Some airfields will have a designated frequency (marked on the landing chart) for use by traffic in circuit or transiting in the vicinity, otherwise 119.1 should be used. Some class G airspace and associated airfields will be marked as a **Common Frequency Zone (CFZ)** with a designated frequency for use in that zone. Some class G airspace and associated airfields will be marked as a **Mandatory Broadcast Zone (MBZ)** with a designated frequency for use in that zone.

Note that while a radio is not mandatory in class G airspace except for MBZs, they are a valuable safety tool. We recommend that you carry and use a radio where practical- even if it is simply to maintain a listening watch for traffic in your vicinity.

Class G Airspace frequencies

Airfields	**MBZs**	**CFZs**	**Other**
designated frequency else 119.1	designated frequency	designated frequency	119.1
recommended	**mandatory**	recommended	recommended
standard circuit/transit calls	on entry and designated intervals	position and intentions	position and intentions

Special Use Airspace

As well as MBZs and CFZs mentioned above, there are a number of other special use airspaces.
Thes extend to varying heights as defined on the VNCs and identified as R, M , D, V, L or P areas. For safety reasons flight into special use airspace may be 'restricted', or some may just be marked 'danger area' as a warning to take extra care.
Restricted areas are mostly military training and weapons firing ranges and extend from a lower level (often the surface) to an upper level. Flight within those areas may be restricted at all times, or may be allowed at times when the restricted area is not activated. ATC will be able to advise if the areas are active especially if that activation is by NOTAM. ATC will generally not be able to issue a clearance to enter. It is up to the pilot in command to comply with the requirements of the controlling authority which will be on the chart or NOTAM. All Restricted areas will have varying levels of entry requirements
Danger areas usually relate to mining or quarrying sites, and to special aviation activities such as fixed training areas or aerobatic areas; it may be prudent to avoid such areas, but there is no restriction on entry. Other special use areas, for example those for hang-gliding or radio-controlled model aircraft flying, are also symbolically marked on aerial charts, as a warning device, but there are no details available in any publication. Similarly mines and quarries marked on charts, but not within a danger area, should only be overflown at a safe height to avoid blasting debris.

Special Use Airspaces					
Restricted Areas	**Military Operating Areas**	**Danger Areas**	**Volcanic Hazard Zones**	**Low Flying Zones**	**Parachute Landing Areas**
R...	MOA M...	D...	VHZ V...	L...	PLA P...
authorisation required	**authorisation required**	consider risk before entry	VMC by day only	briefing before entry	consider risk before entry

Aeronautical Information Publications and NOTAMS

AIP

Airways Corp maintain the AIP, which is the primary source of airspace and navigation information.
The AIP is divided into sections

- GEN
  - National Regulations and Requirements
  - Tables and Codes
  - Services
  - Charges
- ENR
  - **General Rules and Procedures**
  - Air Traffic Support Services
  - ATS Routes
  - Radio Navigation Aids
  - **Navigation Warnings**
- AD1
  - Aerodrome/Heliports Introduction
  - Aerodrome data
- Aerodrome Charts
  - **Approach, landing, ground, departure and general charts for all registered airfields**
- Air Navigation Register
  - Permanent Airspace
  - Temporary Airspace
  - IFR
  - **Right hand circuits**

Those sections marked in **bold** are particularly relevant for the microlight pilot, but we recommend you review all sections for your general knowledge. **You should know your way around the AIP to be competent planning cross-country flight.**

NOTAMS

Notams, derived from the old term 'Notices to Airmen', are issued by Airways Corp and contain "information or instructions concerning the establishment, condition or change in any aeronautical facility , service, procedure or hazard, the timely knowledge of which is essential to persons concerned with flight operations." Notams current at any time are available from the Internet Flight Information Service (IFIS) which we discuss in the 'route planning' module. **You should know how to access weather and NOTAMS from IFIS to be competent planning a cross-country flight.**

VMC and the visual flight rules

The two rule sets mentioned are the **Instrument Flight Rules [IFR**] and the **Visual Flight Rules [VFR]**.
Aircraft operating under the IFR are navigated by reference to cockpit instruments which process data received from ground stations or satellites; IFR flights may operate in both visual meteorological conditions [VMC] or instrument meteorological conditions [IMC] – see below.
VFR flights may only operate in VMC. Most commercial jet operations into or between the major airports would operate only in controlled airspace and under IFR, but turbo-prop and piston engined regional aircraft travelling to or from a smaller city may operate some route sectors in Class G and under VFR. Charter and business aircraft would tend to operate both in controlled airspace under IFR or VFR and in Class G under VFR. Agricultural aircraft would normally be operating in Class G and under VFR. General Aviation training aircraft would tend to operate in and out of a CTR under VFR.

Visual Meteorological Conditions

Microlight and non-instrument rated GA operations may only be conducted in Visual Meteorological Conditions [VMC].The visual meteorological conditions [minima] applicable below 10000 AMSL are:

- Horizontal visibility- 5km. 'Visibility' means the ability to see and identify prominent objects. The problem of course is that there may not be any prominent identifiable objects when flying over featureless areas and, secondly, few people are adept at judging distance from the cockpit.
- Horizontal clearance from cloud – 2km (but see below)
- Vertical clearance from cloud – 1000 feet (but see below)

If operating (in Class G airspace) **at or below 3000 feet AMSL or 1000 feet AGL**, an aircraft may operate **clear of cloud but in sight of the surface**.

Visual Flight Rules

The Visual Flight Rules applicable to ultralight, and most light aircraft, operations are primarily 'see and avoid' other traffic, plus the following specifics:

- VMC must be maintained during the entire flight (climb, cruise and descent)
- the flight conducted in daylight hours,
- the pilot must be able to navigate by reference to the ground

VFR on top

Aircraft cannot be operated on top of cloud which is more extensive than scattered unless it is fitted with serviceable flight and navigation instruments which include an artificial horizon and directional gyro, and the pilot is rated for and current in such flight conditions. **Taking all into account it is unwise for an ultralight aircraft to operate above any cloud cover.**

VFR cruising levels

When flying VFR above 5000 AMSL, it is recommended that aircraft set the altimeter sub-scale to **1013mB** and fly at the designated **VFR cruising levels**. This helps to ensure separation between VFR/IFR traffic, and between aircraft on converging tracks.

- VFR/IFR separation
    - IFR traffic **1000ft levels** (5000,6000,7000, etc)
    - VFR traffic **1000 plus 500ft levels** (5500, 6500, 7500, etc)
- Northbound/Southbound separation
    - 270-090 **ODD levels**
    - 090-270 **EVEN levels**

Remember: **NOSE- North Odds (plus 500), South Evens (plus 500)**

Microlight Flight Operations

Microlight flight operations are covered largely by CAR Part 61 (General aviation rules) and CAR Part 103 (Microlight specific rules). The main restrictions on microlight flights are:

- Day VFR only- plan your flights to complete well in advance of Evening Civil Twilight.
- No flight over congested areas- plan your route away from congested (built-up or public) areas.

Communication and navigation aids

Civil aviation radio communications are conducted in the aviation VHF communications [COMMS] band, 118.00 to 136.975 MHz, where, at 0.025 MHz steps, there are 760 channels possible.

Commonly used inter-pilot air-to-air communications frequency are 123.45 MHz or 133.375 MHz.

VHF Omni-directional Radio Range [VOR] primary air route, homing and position fixing navigation aids operate in the 112.1 to 117.975 MHz aviation VHF navigation [NAV] band. The Instrument Landing System runway localisers, at larger airports, operate in the 108.00 to 112.00 MHz VHF NAV band. Thus the aviation VHF NAV/COMM band is from 108.00 to 136.975 MHz with some 200 channels [at 0.05 MHz intervals] in the NAV band and 760 in the COMMS band. Some handheld airband COMMS transceivers have a very limited VOR receiver capability, but the full NAV/COMM capability is confined to more expensive panel-mounted transceivers/VOR receivers/VOR indicators coupled to a VOR antenna.

Non-directional aviation radio beacons [NDBs], installed to provide a homing facility for smaller aircraft, transmit in medium wave bands between 190 and 535 kHz, but the companion airborne automatic direction finding receivers [ADFs] can also pick up transmissions in the 520 to 1611 kHz AM broadcast band; depending on the power output of the radio station. The broadcasting frequency, latitude and longitude, power output in kW and the height of the mast agl [quite a few are over 600 feet agl and situated on the high ground] for all AM broadcast stations, is contained in the AIP. **Note that NDBs are being phased out of service.**

Distress frequencies and SARSAT

When a pilot is experiencing in-flight difficulties it is advisable to inform others as early as practical and to advise whether the pilot considers the situation to be an emergency or something less. The frequency on which a distress call (a MAYDAY transmission) or an urgency message (a PAN-PAN transmission) is made should be that which is likely to provide a quick response: for example if other aircraft are known to be using a local airfield frequency use that, otherwise use the area frequency, or failing that 121.5MHz.

All microlights flying more than 10NM must be fitted with a 406MHz ELT or carry a 406MHz PLB. These beacons transmit on both 406MHZ (monitored by COSPAS/SARSAT satellites) and 121.5MHz (monitored by international and search aircraft). Beacons with GPS capability transmit the GPS coordinates to the satellite for a virtually instant and accurate fix. Non-GPS beacons are fixed with somewhat less accuracy over a 30 minute period by low-orbit COSPAS satellites.

On receipt of the distress notification from COSPAS, the Mongolia Rescue Coordination Centre first telephones the registered user/s to confirm if this is a genuine emergency activation. If so, rescue action is initiated. The benefit of the 406MHz system is that with the fix information, what would have been a **search and rescue** scenario becomes a **rescue** one, with significantly less delay.

8. Flight Planning

FLIGHT PLANNING AIRSPACE

Module content

- Controlled airspace
- Class G airspace
- Special Use Airspace
- AIP and NOTAM
- VMC and the visual flight rules
- Microlight Flight operations
- Communication and navigation aids
- Distress frequencies and SARSAT

To facilitate safe, orderly use of airspace there are two internationally agreed sets of flight rules (**VFR**/Visual Flight Rules and **IFR**/Instrument Flight Rules) – to which all airspace users must adhere – plus several classes of airspace in which aircraft may operate to take advantage of the implied safety within those airspaces.

Controlled airspace is monitored and most traffic is directed, to varying extents, by ground-based air traffic control [ATC] specialists; and air routes are designated by ground based radio navigation aids. Air Traffic Services [ATS] include a flight information service [FIS] to traffic in the Class G airspace; an alerting service; an air traffic advisory service; and the ATC service within controlled airspace. ATS is provided by the personnel of Airways Corporation of Mongolia, using the VHF radio communications networks.

Uncontrolled airspace is not supervised or controlled- pilots must operate on a **see and be seen** basis following the Visual Flight Rules.

MCAA airspace publications

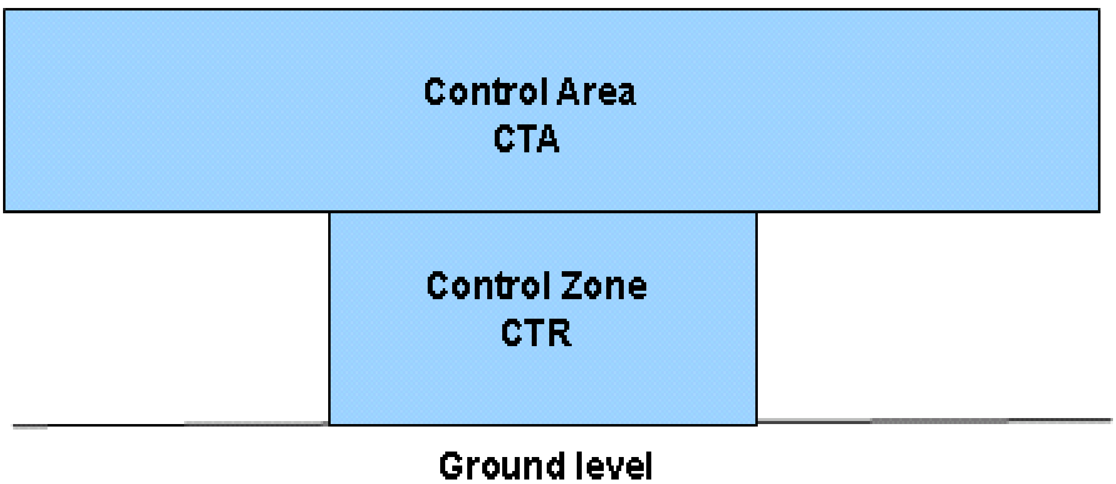
Two useful CAA documents on airspace are:

- MCAA GAP Airspace booklet
- MCAA Airspace poster, AIP

Controlled airspace

Most controlled airspace exists between a lower level, for example 3500 feet amsl and some upper level, for example 9500 feet amsl – or FL95 – and is designated as a **Control Area [CTA]**.

Controlled airspace surrounding a civil or military aerodrome with a manned Air Traffic Control tower is a **Control Zone [CTR]** and starts at ground level and is stepped up to the lower limit of the overlying CTA. The steps provide the airspace for the airport approach and departure paths.



Handy hint

- A Control **Area** has its lower level up in the **air**
- A Control **Zone** goes all the way to the end of the alphabet (**Z**) and all the way to **ground**.

Three of the International Civil Aviation Organisation [ICAO] controlled airspace classes are used in Mongolian; A, C, and D.

Class A airspace is high level en-route airspace, covering most airspace above 9500 AMSL and stepping down where needed to cover main routes and approach/departure sectors. IFR only, radio required, transponder mandatory, clearance required prior to entry.

Class C airspace surrounds major airports starting at ground level (CTRs) and stepped up into mid-level Class C (CTAs) or the high level Class A airspace.

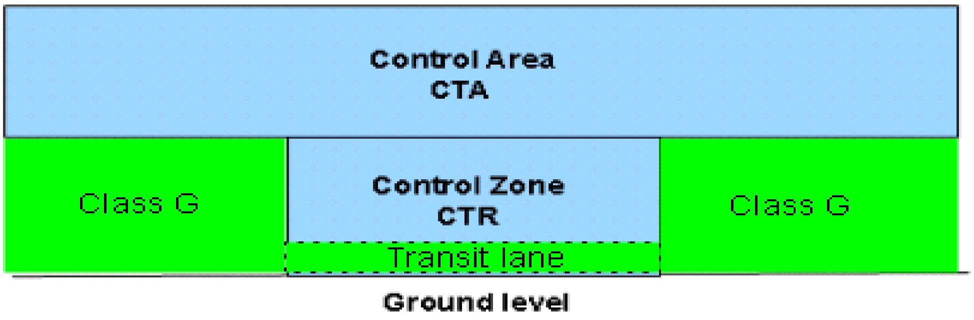
Class D airspace surrounds smaller regional airports with ATS services. The airspace starts at the surface and is stepped up into Class C approach/departure airspace. Mixed IFR/VFR, radio required, usually transponder mandatory, clearance required prior to entry.

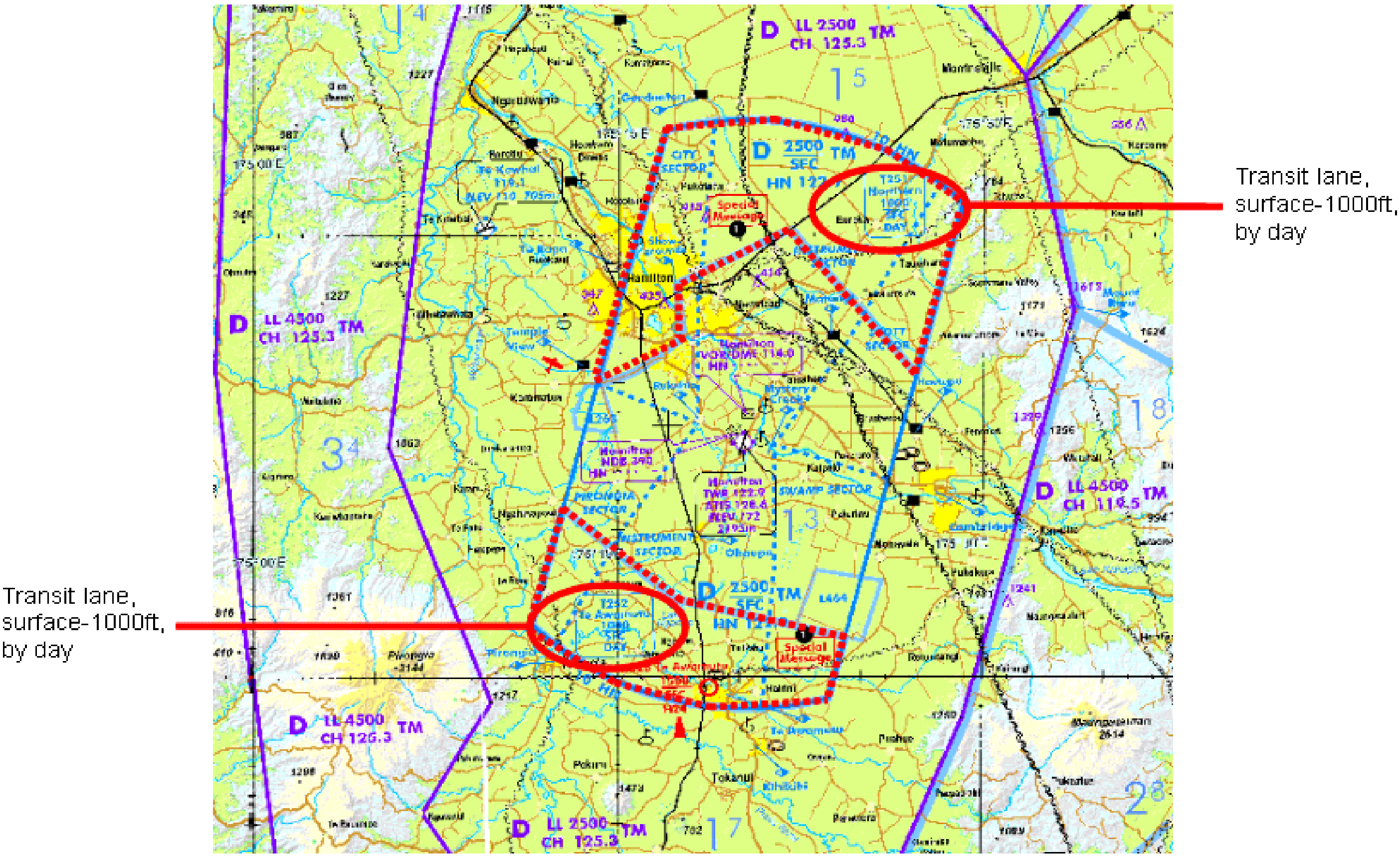
Controlled Airspace		
Class A	**Class C**	**Class D**
Upper airspace	Major airports, approach & departure lanes	Regional airports, approach and departure lanes
IFR only	IFR/VFR	IFR/VFR
Radio required	Radio required	Radio required
Clearance required	**Clearance required**	**Clearance required**
Transponder mandatory	Transponder mandatory	ATS discretion
IFR/IFR separation	IFR/VFR separation	IFR/VFR separation
	IFR/VFR traffic information	IFR/VFR traffic information
	5km visibility	5km visibility
	2km/500 ft from cloud (CTR) 2km/1000ft (CTA)	2km/500 ft from cloud (CTR) 2km/1000ft (CTA)
	250kts	250kts

Most controlled airspace is designated **TM Transponder mandatory**. Transponder equipped aircraft should be transmitting on Mode C (altitude) and code 1200 (general aviation). Non-transponder aircraft may be permitted entry at ATC discretion- either by prior arrangement or by advising **negative transponder** on requesting clearance to enter.

Class G airspace

All airspace which is not promulgated as class A, C or D is designated Class G and open without restriction for flight at or below the lower level of any airspace above. Some controlled airspace may have a Class G **VFR Transit Lane** providing a low level lane undercutting that airspace to facilitate transit or operations without reference to ATC.

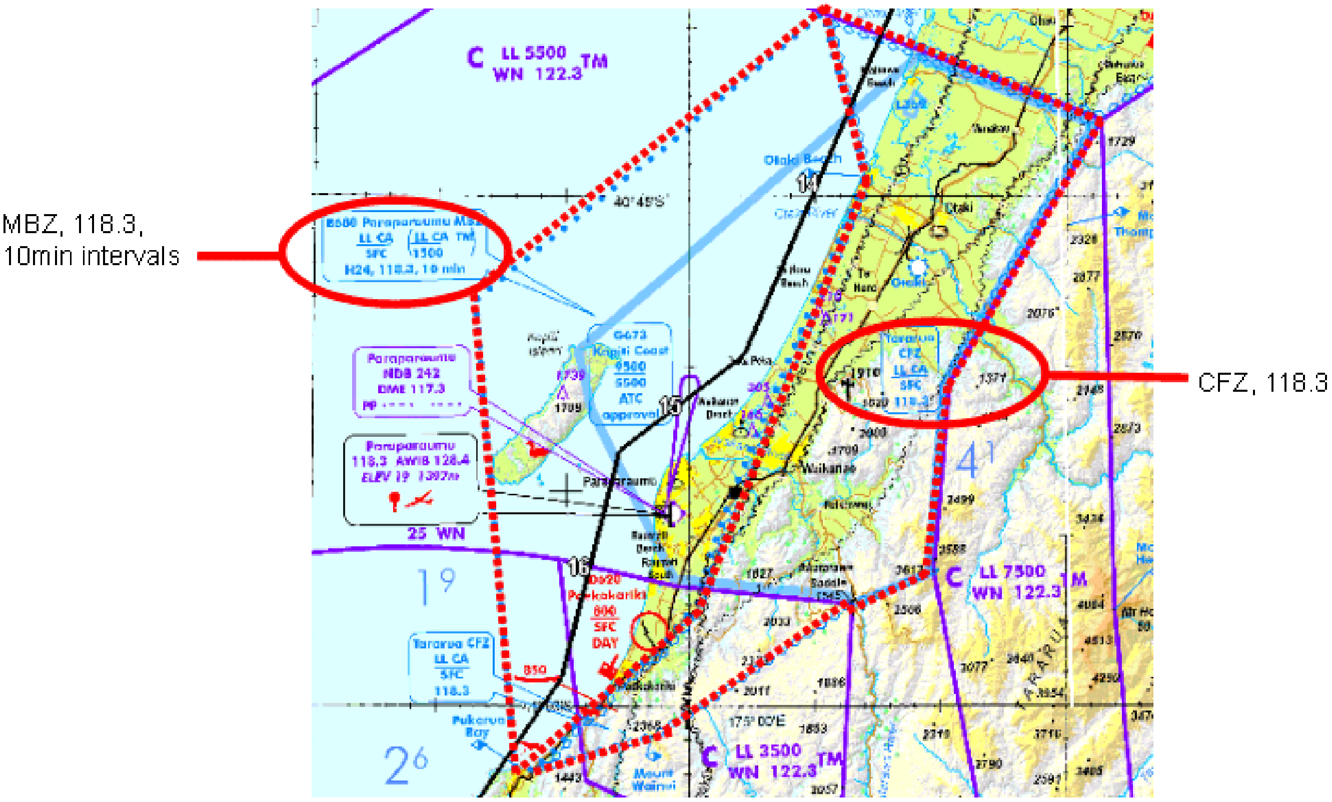




Class G Airspace	
Above 3000 AMSL or 1000 AGL	**Below 3000 AMSL or 1000 AGL**
5km visibility	5km visibility
2km/1000ft from cloud	clear of cloud & in sight of surface
below 10,000ft- 250kts	below 10,000ft- 250kts

To maintain safe separation at airfields in G airspace pilots are required to exercise 'see and avoid' techniques supplemented by VHF monitoring and broadcasting procedures designed to maintain traffic awareness and to manage circuit priorities, where appropriate, in the vicinity of such airfields.

Some airfields will have a designated frequency (marked on the landing chart) for use by traffic in circuit or transiting in the vicinity, otherwise 130 should be used. Some class G airspace and associated airfields will be marked as a **Common Frequency Zone (CFZ)** with a designated frequency for use in that zone. Some class G airspace and associated airfields will be marked as a **Mandatory Broadcast Zone (MBZ)** with a designated frequency for use in that zone.



Note that while a radio is not mandatory in class G airspace except for MBZs, they are a valuable safety tool. We recommend that you carry and use a radio where practical- even if it is simply to maintain a listening watch for traffic in your vicinity.

Class G Airspace frequencies			
Airfields	**MBZs**	**CFZs**	**Other**
designated frequency else 130	designated frequency	designated frequency	130
recommended	**mandatory**	recommended	recommended
standard circuit/transit calls	on entry and designated intervals	position and intentions	position and intentions

Special Use Airspaces					
Restricted Areas	**Military Operating Areas**	**Danger Areas**	**Volcanic Hazard Zones**	**Low Flying Zones**	**Parachute Landing Areas**
R...	MOA M...	D...	VHZ V...	L...	PLA P...
authorisation required	**authorisation required**	consider risk before entry	VMC by day only	briefing before entry	consider risk before entry

Special Use Airspace

As well as MBZs and CFZs mentioned above, there are a number of other special use airspaces.
These extend to varying heights as defined on the VNCs and identified as R, M , D, V, L or P areas. For safety reasons flight into special use airspace may be 'restricted', or some may just be marked 'danger area' as a warning to take extra care.
Restricted areas are mostly military training and weapons firing ranges and extend from a lower level (often the surface) to an upper level. Flight within those areas may be restricted at all times, or may be allowed at times when the restricted area is not activated. ATC will be able to advise if the areas are active especially if that activation is by NOTAM. ATC will generally not be able to issue a clearance to enter. It is up to the pilot in command to comply with the requirements of the controlling authority which will be on the chart or NOTAM. All Restricted areas will have varying levels of entry requirements
Danger areas usually relate to mining or quarrying sites, and to special aviation activities such as fixed training areas or aerobatic areas; it may be prudent to avoid such areas, but there is no restriction on entry. Other special use areas, for example those for hang-gliding or radio-controlled model aircraft flying, are also symbolically marked on aerial charts, as a warning device, but there are no details available in any publication. Similarly mines and quarries marked on charts, but not within a danger area, should only be overflown at a safe height to avoid blasting debris.

Aeronautical Information Publications and NOTAM

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  - Radio Navigation Aids
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  - **Approach, landing, ground, departure and general charts for all registered airfields**
- Air Navigation Register
  - Permanent Airspace
  - Temporary Airspace
  - IFR
  - **Right hand circuits**

Those section marked in **bold** are particularly relevant for the microlight pilot, but we recommend you review all sections for your general knowledge. **You should know your way around the AIP to be competent planning cross-country flight.**

NOTAM

NOTAM, derived from the old term 'Notices to Airmen', are issued by Airways Corp and contain "information or instructions concerning the establishment, condition or change in any aeronautical facility , service, procedure or hazard, the timely knowledge of which is essential to persons concerned with flight operations." NOTAM current at any time are available from the Internet Flight Information Service (IFIS) which we discuss in the 'route planning' module. **You should know how to access weather and NOTAM from IFIS to be competent planning a cross-country flight.**

VMC and the visual flight rules

The two rule sets mentioned are the **Instrument Flight Rules [IFR**] and the **Visual Flight Rules [VFR]**.
Aircraft operating under the IFR are navigated by reference to cockpit instruments which process data received from ground stations or satellites; IFR flights may operate in both visual meteorological conditions [VMC] or instrument meteorological conditions [IMC] – see below.
VFR flights may only operate in VMC. Most commercial jet operations into or between the major airports would operate only in controlled airspace and under IFR, but turbo-prop and piston engined regional aircraft travelling to or from a smaller city may operate some route sectors in Class G and under VFR. Charter and business aircraft would tend to operate both in controlled airspace under IFR or VFR and in Class G under VFR. Agricultural aircraft would normally be operating in Class G and under VFR. General Aviation training aircraft would tend to operate in and out of a CTR under VFR.

Visual Meteorological Conditions

Microlight and non-instrument rated GA operations may only be conducted in Visual Meteorological Conditions [VMC].The visual meteorological conditions [minima] applicable below 10000 AMSL are:

- Horizontal visibility- 5km. 'Visibility' means the ability to see and identify prominent objects. The problem of course is that there may not be any prominent identifiable objects when flying over featureless areas and, secondly, few people are adept at judging distance from the cockpit.
- Horizontal clearance from cloud – 2km (but see below)
- Vertical clearance from cloud – 1000 feet (but see below)

If operating (in Class G airspace) **at or below 3000 feet AMSL or 1000 feet AGL**, an aircraft may operate **clear of cloud but in sight of the surface**.

Visual Flight Rules

The Visual Flight Rules applicable to ultralight, and most light aircraft, operations are primarily 'see and avoid' other traffic, plus the following specifics:

- VMC must be maintained during the entire flight (climb, cruise and descent)
- the flight conducted in daylight hours,
- the pilot must be able to navigate by reference to the ground

VFR on top

Aircraft cannot be operated on top of cloud which is more extensive than scattered unless it is fitted with serviceable flight and navigation instruments which include an artificial horizon and directional gyro, and the pilot is rated for and current in such flight conditions. **Taking all into account it is unwise for an ultralight aircraft to operate above any cloud cover.**

VFR cruising levels

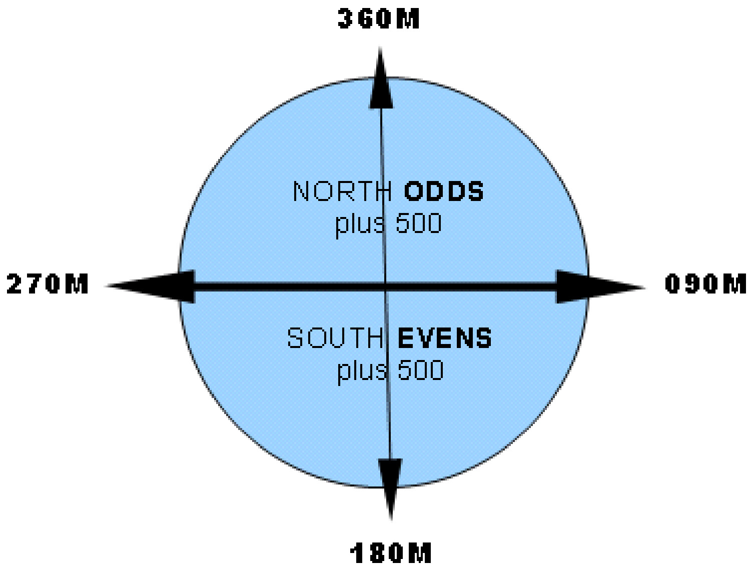
A pilot-in-command of an aircraft operating within the Mongolian FIR under VFR in level cruising flight at more than 3000 feet AMSL or 1000 feet AGL (whichever is the higher) must, unless otherwise authorised by an ATC unit, maintain the following altitudes or flight levels:

- when operating at or below 13 000 feet AMSL and-
  - (i) on a magnetic track of 360° clockwise to 179°, any odd hundred foot altitude AMSL plus 500 feet; or
  - (ii) on a magnetic track of 180° clockwise to 359°, any even hundred foot altitude AMSL plus 500 feet:
- when operating at or above FL150, up to and including FL275 and-

- o (i) on a magnetic track of 360° clockwise to 179°, any odd flight level plus 500 feet beginning at and including FL155; or
- o (ii) on a magnetic track of 180° clockwise to 359°, any even flight level plus 500 feet beginning at and including FL165.

A pilot-in-command of an aircraft operating within the Mongolian FIR under VFR must not maintain level cruising flight-

- at any level between 10 000 feet AMSL and FL120 unless otherwise authorised by an ATC unit for flights in controlled airspace; and
- at any flight level below FL120 when an area QNH zone setting is 980 hPa or



less.

Remember: **NOSE- North Odds (plus 500), South Evens (plus 500)**

Microlight Flight Operations

Microlight flight operations are covered largely by MCAR Part 61 (General aviation rules) and MCAR Part 103 (Microlight specific rules). The main restrictions on microlight flights are:

- Day VFR only- plan your flights to complete well in advance of Evening Civil Twilight.
- No flight over congested areas- plan your route away from congested (built-up or public) areas.

Communication and navigation aids

Civil aviation radio communications are conducted in the aviation VHF communications [COMMS] band, 118.00 to 136.975 MHz, where, at 0.025 MHz steps, there are 760 channels possible.

Commonly used inter-pilot air-to-air communications frequency are 123.45 MHz or 133.375 MHz.

VHF Omni-directional Radio Range [VOR] primary air route, homing and position fixing navigation aids operate in the 112.1 to 117.975 MHz aviation VHF navigation [NAV] band. The Instrument Landing System runway localisers, at larger airports, operate in the 108.00 to 112.00 MHz VHF NAV band. Thus the aviation VHF NAV/COMM band is from 108.00 to 136.975 MHz with some 200 channels [at 0.05 MHz intervals] in the NAV band and 760 in the COMMS band. Some handheld airband COMMS transceivers have a very limited VOR receiver capability, but the full NAV/COMM capability is confined to more expensive panel-mounted transceivers/VOR receivers/VOR indicators coupled to a VOR antenna.

Non-directional aviation radio beacons [NDBs], installed to provide a homing facility for smaller aircraft, transmit in medium wave bands between 190 and 535 kHz, but the companion airborne automatic direction finding receivers [ADFs] can also pick up transmissions in the 520 to 1611 kHz AM broadcast band; depending on the power output of the radio station. The broadcasting frequency, latitude and longitude, power output in kW and the height of the mast agl [quite a few are over 600 feet agl and situated on the high ground] for all AM broadcast stations, is contained in the AIP.

Distress frequencies and SARSAT

When a pilot is experiencing in-flight difficulties it is advisable to inform others as early as practical and to advise whether the pilot considers the situation to be an emergency or something less. The frequency on which a distress call (a MAYDAY transmission) or an urgency message (a PAN-PAN transmission) is made should be that which is likely to provide a quick response: for example if other aircraft are known to be using a local airfield frequency use that, otherwise use the area frequency, or failing that 121.5MHz.

All microlights flying more than 10NM must be fitted with a 406MHz ELT or carry a 406MHz PLB. These beacons transmit on both 406MHZ (monitored by COSPAS/SARSAT satellites) and 121.5MHz (monitored by international and search aircraft). Beacons with GPS capability transmit the GPS coordinates to the satellite for a virtually instant and accurate fix. Non-GPS beacons are fixed with somewhat less accuracy over a 30 minute period by low-orbit COSPAS satellites.

On receipt of the distress notification from COSPAS, the Mongolian Rescue Coordination Centre first telephones the registered user/s to confirm if this is a genuine emergency activation. If so, rescue action is initiated. The benefit of the 406MHz system is that with the fix information, what would have been a **search and rescue** scenario becomes a **rescue** one, with significantly less delay.

CHARTS AND COMPASS

Module content

- Latitude and longitude
- Air navigation charts
- Recommended charts
- Map topography
- Magnetic variation and deviation
- Things that are handy to know
- Stuff you don't need to know

Ground maps are essential for navigation under the Visual Flight Rules- *in fact they are required to be carried on a cross-country*.

The maps, or charts, used for air navigation are overlaid with a coordinate grid showing the local meridians of longitude and the parallels of latitude. In aviation locations are generally defined in terms of latitude and longitude and chart directions are referenced in relation to **true north**, but unfortunately the prime navigation instrument – the compass – aligns itself with the **magnetic north** pole.

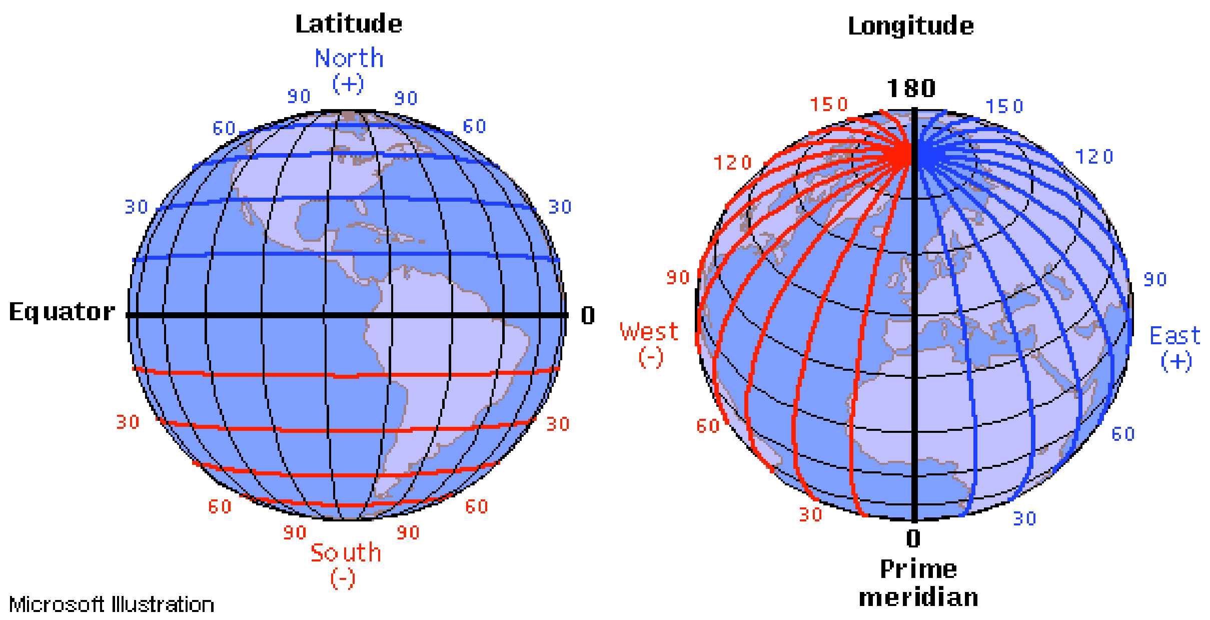
Latitude and longitude

Parallels of latitude are imaginary circles drawn around the Earth starting from the equator and reducing in circumference toward the poles. Parallels are identified by the angle which they subtend with the centre of the Earth (measured in degrees, minutes and seconds) and whether they lie north or south of the equator.

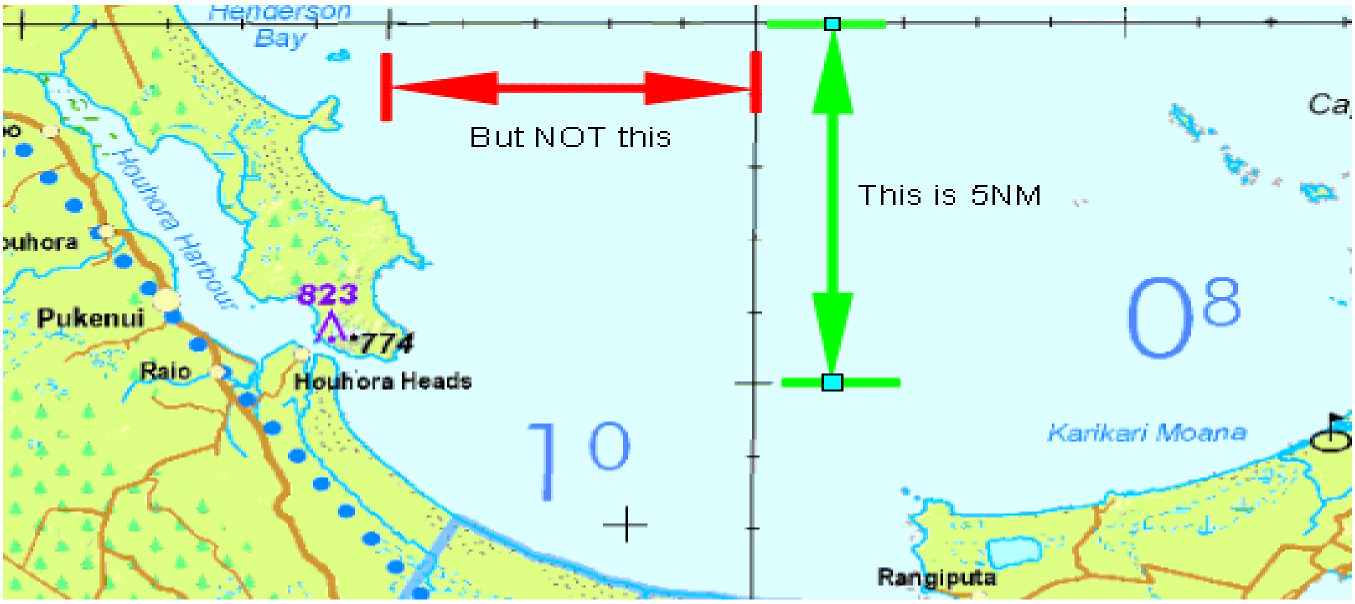
- The **equator** has a latitude of 0°
- The **North Pole** has a latitude of 90°N
- The **South Pole** has a latitude of 90°S.
- Mongolian lies between N41°30' () and N52°30' ()
- The equator is a **great circle** in that it is formed by a plane that passes through the Earth's centre, thus bisecting the Earth's sphere.

Meridians of longitude are half great circles, perpendicular to the equator, that extend from pole to pole. The meridians are identified by the angle which they subtend with the centre of the Earth, measured in degrees, minutes and seconds east or west, from the *'prime meridian*.

- The **prime or zero meridian** – 0° longitude – passes close to Greenwich, England.
- Subsequent meridians are identified as °East or °West around to 180°.
- Mongolian lies between E87°40 (Altai Tavan Bogd) and E119°50' (East Cape)



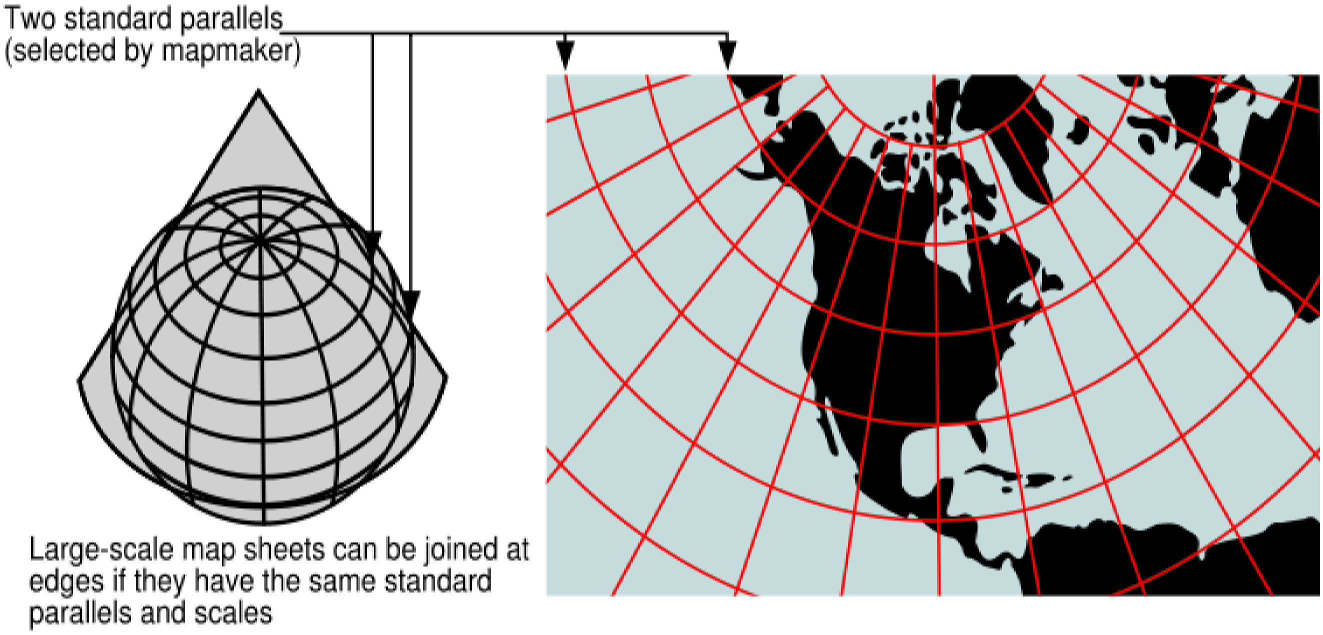
One nautical mile is the length, at the Earth's surface, of one minute of arc of a great circle and the International Nautical Mile is 1852 metres or 6076.1 feet. Consequently one degree of latitude (measured along a meridian) has an equivalent surface distance of 60 nautical miles and one second of latitude is about 31 metres. However seconds of arc are not used in aeronautical publications, latitude and longitude being expressed in degrees plus minutes to two decimal places. For example Te Kowhai airfield north of Hamilton is located at S37°44.42' E175°09.31'. In ultralight navigation accuracies down to one hundredth of a minute (18.5 metres) are generally unnecessary so we round up/down to the nearest minute. 'Lat/long' coordinates should be expressed with the direction from the equator/prime meridian first (S and E), then a group representing the degrees (S37° and E147°) followed by a group for the minutes (S37°44' and E175°09').



A **knot** is a speed of one nautical mile per hour.

Air navigation charts

A map intended for air or marine navigation is a chart and the chart graticules are latitude and longitude, with the meridians more or less vertical on the sheet. As the Earth is a sphere there has to be a technique to map the image of the surface of the 3-dimensional sphere onto a flat 2-dimensional chart without overly distorting the represented areas. The most suitable method for aeronautical charts is 'Lambert's conformal conic' projection which, although distorting areas a little, allows that the great circle arc, the shortest distance between two points on the surface of a sphere, is accurately represented by a straight line drawn on the chart, and distances anywhere on the chart have the same scale.

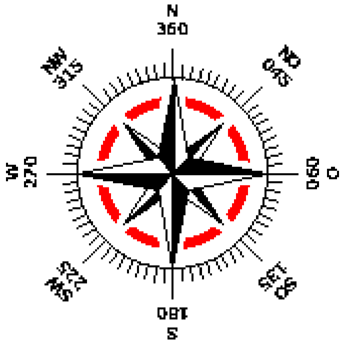


The meridians on such charts taper towards the poles; on a southern hemisphere chart the meridian spacing at the bottom of the sheet is noticeably less than that at the top. Also you can see that the parallels are slightly curved. If you draw a straight line diagonally across the chart the angle that great circle route subtends with each meridian varies slightly across the chart.

All Mongolian aeronautical charts use the Mongolian Map Grid (**MGLMG**) projection. This is a form of conformal conic projection with the following useful characteristics:

- **Centred on Mongolian** (Central meridian E106, Latitude origin N46)
- **No distortion of distances** between any two points.
- **The central meridian is vertical on the chart**, aligned N-S.
- **The shortest distance between any two points is a straight line**.
- For all practical navigation purposes, **distances and headings can be taken directly off the chart**.

The scales used for aeronautical charts are the representative fractions 1:1 000 000, 1:500 000 and 1:250 000. The latter scale means that an actual distance of 250 000 centimetres (2.5 km) is represented by one centimetre on the chart.



Directions on air navigation charts are always expressed as the angular distance from the North Pole – true north – in whole degrees from 0° at north clockwise to 360°, i.e. north is both 0° and 360 ° (though usually expressed as the latter), e.g. the direction due east from a particular location is 090°. These directions may be described as bearings, headings, courses or tracks depending on the application. Directions are usually associated with distances expressed in nautical miles thus the bearing and distance of a location 55 nm due east would be expressed as bearing 090°/55.

Global navigation satellite systems (eg, GPS) produce ellipsoidal heights. This is because mathematical calculations on the ellipsoid are simpler to carry out than on the undulating mean sea surface. Some GPS receivers will output heights in relation to sea level, however to derive these they will have applied a geoid model to transform the ellipsoidal heights.

The International Civil Aviation Organisation specifies that the local value [known as the 'N value'] of the geoid-ellipsoid separation should be shown on aeronautical navigation charts but the values are not shown on Mongolian charts. The local N value is of little significance to recreational aviators (although it should be noted that a GPS instrument may give an

apparently incorrect height if the software doesn't adjust for the local 'N' value) but may be of great significance to IFR pilots and designers of GPS approaches when GPS achieves sole-means navigation status.
In practical microlighting visual navigation applications, the difference between MGLGD2000 reference and Mean Sea Level is not significant. In Northland you may be 35m closer to the ground than you thought you were- just look out the window when you are landing!.

Recommended charts

The charts recommended for ultralight and light aircraft flight planning, in-flight navigation and sourcing VHF radio communications data, are:
Visual Planning Charts (VPC). These are two 1:1,000,000 charts on a single double sided sheet covering Mongolian-North and South islands. They are intended for pre-flight planning of routes, distances and time estimates. **They do not have detailed low-level and terminal airspace information, and should not be used for in-flight navigation**.
Visual Navigation Charts (VNC). These are a series of charts of varying scales- 1:500,000 (B series), 1:250,000 (C series) and 1:125,000 (D Series). They contain detailed and complete information on airspace below 9500 feet, and are intended for pre-flight planning and in-flight navigation. The charts are updated on any significant change in airspace or navigation information.
It is a good idea to have all the charts covering your intended area of operations- the smaller scale charts (1:500,000) are suitable for less complex airspace areas, but the large scale charts (1:250,000 or 1:125,000) allow you to 'zoom' in on critical areas with great detail and clarity**- very** useful.

Airport at different map scales

Information contained in the VNCs includes:

- **Airspace-** boundaries, upper and lower levels, ATS station and frequency, transponder requirements
- **Maximum elevation figures** (MEF) for each 15 minute quadrangle.
- Detailed **contours, elevations and spot heights**.
- Main **roads, rivers, rail and transmission lines**.
- **Certified airfields**, frequencies, elevation, length and vector.
- **Special airspace-** GFAs, SPAs, MBZs, transit lanes, restricted areas, danger areas, MOAs- and conditions of entry.
- **Reporting points**

The VNCs are essential flight planning and navigation tools- you are well advised to keep a personal set covering the areas you fly. And it is important that you update on each revision- bad information can be more dangerous than no information.

Carriage of flight documentation

From Civil Aviation Regulations MCAR Part 91:
91.221 Flying equipment and operating information

- (a) A pilot-in-command of an aircraft must ensure that the following equipment and information, in current and appropriate form, is accessible to every flight crew member of the aircraft:
    - (1) an accurate means of indicating the time:
    - **(2) appropriate aeronautical charts:**
    - (3) for IFR operations, every appropriate navigational en route, terminal area, approach, and instrument approach and departure chart:
    - (4) for night operations, an operable electric torch for every flight crew member.

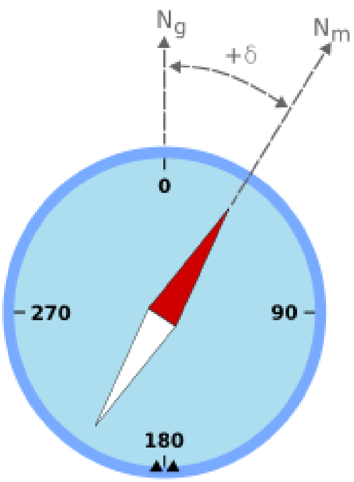
Map topography

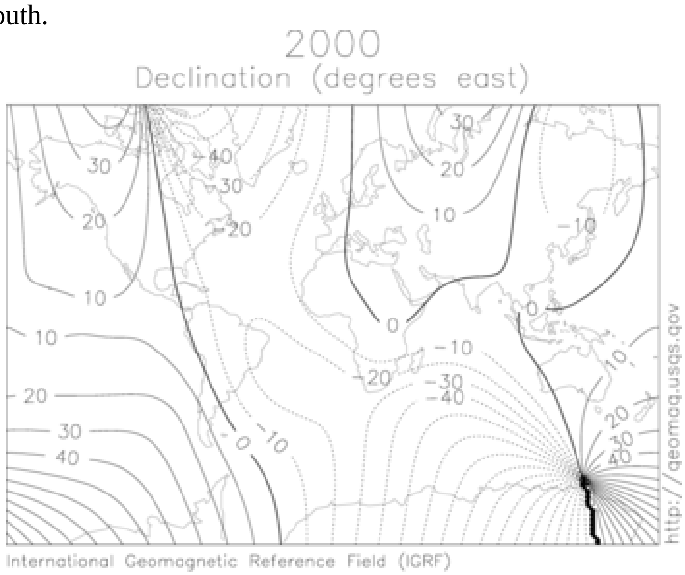
Aircraft operating under the VFR must navigate by visual reference to the ground. The lower the level at which a flight is planned the more important it is that the pilot is able to visualise a three dimensional image of the terrain from the graphical details presented by the two dimensional topographic chart – by the usage of colour, symbols and lettering. To assist this visualisation VNCs display tinted topographic contours signifying surface areas from MSL to 500ft and thereafter at 1000ft intervals. The shape of the contours and the width between them indicates the form of the land and the gradient. The closer the contour lines (i.e. the narrower the colour bands) are to each other the steeper the gradient.

In addition, the **maximum elevation figure** (MEF) within each 30' x 30' chart graticule is recorded in bolder lettering than other spot elevations. The elevations are shown in thousands (large numerals) and hundreds (smaller numerals) of feet- eg **15** means 1500 feet.
Vegetation is shown on VNCs as well as towers, spans and similar obstructions to low flying aircraft. Railroads, rivers, power transmission lines and major roads are depicted.

Magnetic variation and deviation

The basic navigation instruments are the magnetic compass and the watch. The 'standard' compass is essentially a bar magnet freely suspended in a lubricating fluid designed to damp out oscillations, vibrations and swings caused by aircraft accelerations. The bar magnet, which may be a needle or part of a circular compass card, aligns itself with the Earth's local magnetic lines of force with the north seeking end pointing roughly north. The Earth's magnetic field is systematically surveyed so that the difference between the direction at which a compass points (**magnetic north**) and the direction of true north is measured. That difference is called **variation**, or declination if you are of a scientific bent, and is expressed in degrees of arc east or west of true north. The magnetic lines of force at any location may also be substantially varied by local magnetic anomalies, substantial iron ore deposits for example. Lines on a chart joining locations with equal magnetic variation are called **isogonals**, or isogonic lines, and are shown on VNCs, at one degree intervals, as dashed purple lines. The local variation may also be shown numerically on some charts. The isogonals on Mongolian charts vary from 18° east in the north to 23° east in the south.





This means that if you want to fly from A to B the direction ascertained from the chart will be relative to true north – the **true course** – and let's say it is due west, 270°. If you then set 270° on the aircraft compass and fly that heading then your track over the ground will not be due west but will vary according to the variation. Let's say the variation is 20°east then the true course you are flying will be 290°. This small complication requires that when you have finally calculated the true course you have to fly to get from A to B, after allowing for the effects of wind, then you need to convert it to a magnetic heading.
The conversion rule used for at least the past 70 years is

- Variation east, magnetic heading least
- Variation west, magnetic heading best.

So if the local variation is 20° east the magnetic heading will be the true course minus 20°, e.g. true course 010°, magnetic heading 350°.
For all wind velocities, given in meteorological forecasts and actuals, the directions are relative to true north, except if you happen to hear a broadcast from a CTR tower controller (or an ATIS – Automatic Terminal Information System – broadcast) who provides the wind direction as magnetic, because the airfield runway numbers are relative to magnetic north.
For further information on variation/declination I suggest you read Chris Goulet's FAQ page. Also have a look at the magnetic variation Java applet in Pangolin's 'Almanac On-Line'. This company is associated with marine rather than aviation activities but their 'Almanac On-Line' has some interesting Java applets.

Aircraft magnetic compass

Aircraft compasses are also deflected by magnetic fields within the aircraft, some related to ferrous engine/structural metals, others related to electrical currents. These aircraft magnetic fields produce heading errors – compass **deviation** – which vary according to the aircraft course, either reducing or increasing the Earth's magnetic field. These errors can be quite significant, 30° or more, and any magnetic field within about one metre of the compass may have a discernible effect. Mobile telephones in the cockpit may also affect the compass. Compass error is the combination of variation and deviation adjustment necessary to determine the compass heading which will provide the true course.
A bar magnet aircraft compass will have screw adjustable compensating magnets to negate or at least reduce the effect of these magnetic fields. The compass, and aircraft, must be 'swung' to make these adjustments and the residual deviation errors are noted on a compass correction card displayed in the cockpit. A procedure for 'swinging the compass' is contained in the Australian regulation CAO108. We will go further into compass deviation in the enroute adjustments module.

A handy mnemonic:

- Can.............compass
- Ducks..........+ deviation
- Make...........= magmetic
- Vertical........+ variation
- Turns..........= true

Bar magnet compasses are also affected by vibrations, aircraft accelerations, inertia and centripetal force when turning; and thus tend to be constantly shifting. Compass acceleration errors are most apparent when the aircraft is on an east/west heading and least apparent when on a north/south heading. The turning errors require the pilot to make an undershoot/overshoot adjustment when changing heading.

Another handy mnemonic:

the example you quote the aircraft is in the northern hemisphere so use **UNOS: Underturn North, Overturn South** and in the southern hemisphere use **ONUS: Overturn North, Underturn SouthIn**

To overcome these errors a magnetic compass may be accompanied by a gyroscopic instrument which indicates the direction in which the aircraft is heading, without being subject to external forces. This electrically or suction operated 'DG' or 'DI' is initially aligned with the compass before take-off and needs to be realigned occasionally during flight; however very few ultralights are equipped with a DG.
Electronic flight information systems [EFIS or 'glass cockpits'] are now becoming much cheaper and thus a reasonable proposition for amateur-built light aircraft. These systems use solid state electronic componentry plus software to present a cockpit display incorporating the functions of most single flight instruments. In such systems magnetic field strength sensors [magnetometers] are used to provide a three dimensional magnetic compass which displays magnetic heading without acceleration, attitude or turning errors; thus it also incorporates the directional gyro facility.

Things that are handy to know

- Marine navigation charts normally use Mercator's (a 16th century Flemish geographer) cylindrical projection where rhumb lines are straight and great circle plots are curved. If you want to see how a great circle route appears on such a chart I suggest you use the magnetic variation Java applet in Pangolin's 'Almanac On-Line' and indicate a great circle start point at Sydney, Australia and an end point at London, England.
- A rhumb line is a line drawn so that it crosses the meridians at a constant angle, but it is not the shortest distance between two points: an aircraft flying a constant heading would be following a rhumb line course. The concept of choice between a great circle or rhumb line route is interesting but inconsequential to a light aircraft navigator.

Stuff you don't need to know

- Maps that lack contours, like street maps, are planimetric - i.e. flat.
- Large scale maps are those with a scale of 1:70 000 or less.
- The precise WGS84 latitude and longitude of any apparently fixed surface feature in Mongolian varies with time as the tectonic plates collide and slide from Fiordland to East Cape at a rate approximating 5cm per year.
- The shortest distance between say Ulaanbaatar and Los Angeles is a straight line [a tunnel] joining those locations and passing through the Earth. The great circle route follows that tunnel on the surface.

ROUTE PLANNING

Module content

- The four navigation techniques
- Fuel planning
- Airspace and Airfield check
- Route construction
- Plotting the route on a chart
- Obtaining weather forecasts and NOTAM

The four elements of navigation are

- position
- direction
- distance
- and time

And distance by time is ground speed.
There are four systems or techniques of air navigation

- pilotage
- dead reckoning
- position fixing
- and homing

Pilotage, dead reckoning and (with the introduction of GPS) homing are the primary navigational techniques for pilots of light recreational aircraft and, like many air navigation terms, they are centuries old nautical terms.

The first steps in flight planning entail

- ascertaining general weather conditions
- selection of a safe route
- plotting it on a chart
- checking the status of airfields along the route
- and calculating preliminary fuel requirements.

This is somewhat iterative- you will first have an idea of your destination and route options, and will refine these based on weather, airfields and fuel requirements. But these plans may well change on the day or in flight due to weather or other considerations. It is always prudent to have a Plan B and Plan C up your sleeve should you need it.

The four navigation techniques

Pilotage (map following)

Pilotage is navigation by visual reference to landmarks – the art of visual track keeping – which thus requires that the ground is, more or less, continually in sight. In the early days all air navigation was by pilotage with some crude dead reckoning, indeed the first Pilots' Directions published by Elrey B. Jeppesen in the 1920s, for the early air mail pilots in the USA, were just notes about the landmarks along a route. As accurate aerial charts became available then aerial dead reckoning became much more refined.

Map reading is the essence of pilotage.

It entails

- a continuous **in-flight survey of the planned route** (pre-plotted on the chart);
- identification of the upcoming chart features on the ground, i.e. **reading from map to ground** in continuous contact;
- and determining the **actual location relative** to the planned position.

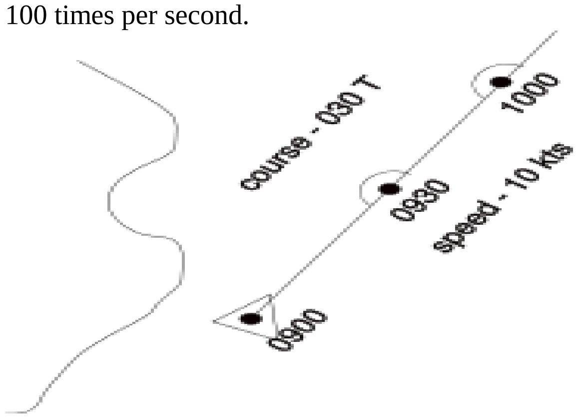
Following the determination of that position (and thus the actual path over the ground) dead reckoning is then used to determine the "navigation solution", i.e.

- the **ground speed and the track error** (the angular difference between the intended route and the actual path)
- the subsequent **course correction(s)** necessary to regain and maintain the intended route
- and a **revised arrival time**.

Only when uncertain of your position will it be necessary to note prominent ground features – and their relative positions – and then find such juxtaposition of features on the map, i.e. reading from ground to map. Map interpretation is an acquired skill; inability to relate the map to the ground features below is not an uncommon experience on the initial attempts. Some people find it very difficult to master. In more remote, and rather featureless, areas what seem to be the major features on the surface may not be discerned on the chart, and vice versa.

Dead reckoning

Dead reckoning [DR] is deriving the current position, or a future position, mathematically from a planned position or the last known position. DR for light aircraft is, or should be, essentially simple navigation by clock, compass and mental arithmetic. Most of the DR for RPT and military aircraft is done within the electronic circuitry of advanced navigation systems such as inertial navigation systems [INS] which calculate a new spatial position, from the previous position, about 100 times per second.



DR was born in the early days of oceanic sailing vessels: every hour or two during the voyage the log (a quadrant shaped piece of wood weighted to float upright with an attached log-line knotted at intervals) was dropped over the stern of a vessel under way and the vessel's speed was reckoned from the amount of line paid out over a particular period of time. In 1637 an English mathematician and navigator, Richard Norwood, calculated that the spacing between knots should be 47.25 feet with a 28 second sand glass being used as the timer. If you do the calculation, using the then estimated 6075 feet to the nautical mile, you will see that the number of knots that passed over the stern rail during the 28 second period equals the ship's speed in nautical miles per hour: hence knots. The log was presumed to be 'dead in the water' i.e not dragged by the ship or affected by tide or current. Each reading was marked on a log-slate and, during each watch, the course, speed and distance reckonings – adjusted for tide and current – were entered in the logbook.

Dead reckoning has a limitation in that errors in plotting, wind velocity estimation, course steering and timing etc are cumulative and the true position of the aircraft can't be verified unless it can be determined by pilotage [landmark reference] or some other position fixing technique.

Position fixing

Position fixing navigation techniques are usually radio based and encompasses simple techniques such as plotting the intersection of the bearings from two radio beacons through more complex systems such as VOR/DME to Loran, Decca, Omega and GPS which are both position fixing and homing. Such systems usually incorporate some degree of electronic dead reckoning.

The typical GPS unit uses continuous position fixing (GPS) plus electronic dead reckoning to calculate a new bearing, distance and time to the next waypoint.

The non-radio based position fixing techniques are celestial; star sights or sun sights.

Homing

Homing is radio based and encompasses non directional beacon [NDB] and VHF omni range [VOR] homing through to Instrument Landing Systems [ILS] and Global Positioning System [GPS].

The pages of this navigation guide cover the essentials of pilotage and manual DR but a section on supplementary navigation techniques provides an introduction to NDB, VOR and GPS for VFR recreational pilots. In addition there is a module describing electronic planning and navigation systems for light aircraft.

Fuel planning

Fuel related accidents or incidents are a common occurrence, caused by fuel exhaustion [all fuel on board consumed] or fuel starvation [pilot mishandling of the fuel system so that available fuel is blocked from delivery to the engine] — please ensure you are not this week's statistic.

Before undertaking a cross country flight the pilot must know the **total usable fuel** capacity and the **rate of consumption** at the planned cruising speed. The fuel consumption rates supplied by engine/aircraft manufacturers, unless contained in a formal pilot's operating handbook, must be viewed somewhat skeptically, they may be achievable with an 'as new' engine cruising at the best endurance power setting but not reflective of the consumption at a more useful cruise speed, say that at 75% power.

Fuel must be allowed for consumption at **the departure airfield, for the climb and for circuit delays and landing at the destination**. In addition the pilot is required to plan a fixed fuel reserve. The amount planned is a matter of personal discretion but should not be less than 30 minutes in good flying conditions but a greater amount if there is any doubt about the wind velocities or other conditions. *This reserve should not be planned for use, i.e. wherever the aircraft is landed there ought to be at least 30 minutes fuel in the tanks.*

It is vital to be able to measure fuel consumption during flight so a **reasonably accurate fuel contents gauge, sight gauge or an inflight view of the fuel tank** content is necessary. It is good practice to maintain a history log in the aircraft where the actual fuel consumption per flight hour is entered at the conclusion of each flight. Such a history log, showing fuel consumption history, provides valuable information both for future flight planning and for monitoring engine performance.

When planning a cross country flight the objectives are to arrive at the planned destination safely, with a reasonable reserve of fuel in hand and without affecting the safety of others whilst enroute; or even creating a possibility that safety might be affected. But remember the first rule of aviation – fly the aeroplane at all times, navigate when able and always be a few minutes ahead of the aeroplane. When navigating a light aircraft, and particularly an open cockpit ultralight, a person's capacity for mental arithmetic is not as good as it is when sitting at home. Nor is it easy, or maybe even possible, to manipulate navigational tools in flight and it is very difficult to handle charts, pencils and notepads in the cockpit: thus preflight preparation should be directed towards reducing and simplifying the inflight work load.

You should have a good acquaintance with the flight envelope of the aircraft, both with and without a passenger. In particular you must know the optimum cruise speeds obtained when cruising at say 75% power plus the proven fuel consumption, in litres per hour – at that throttle setting and aircraft weight.

Calculate the maximum sector time allowed as follows

Calculation	Example
Total Usable Fuel	64 litres
divided by **Fuel Burn**	16 litres/hour
equals **Fuel Endurance**	4 hours
less **Reserve**	30 minutes
equals **Maximum Advisable Sector Time**	3 hours 30 minutes

Never equate fuel consumption with distance- it is TIME you have in your tank.

Light aircraft consume 40% to 50% more fuel in a maximum power climb than at a normal cruise setting. It is normal practice to initially climb away at best rate of climb speed [Vy] until a safe height is reached, then airspeed is allowed to increase to a suitable enroute climb speed, while maintaining maximum allowed climb power, until the cruise altitude is reached. The extra fuel consumption during the climb can be estimated from the normal rate of climb achieved e.g. rate of enroute climb 250 feet/minute = four minutes per 1000 feet, then extra fuel consumed [~50%] is two minutes fuel per 1000 feet climbed. This extra fuel will be used whatever power setting is used in the climb, it is the chemical energy exchanged for the potential energy of height.

You should know these numbers for your aircraft from memory- Flight planning

- **Fuel capacity-** total usable fuel
- **Fuel burn-** rate that it is burnt at cruise
- **Fuel endurance-** total time in the tank

During flight

- **time remaining in your tank**

Airspace and Airfield check

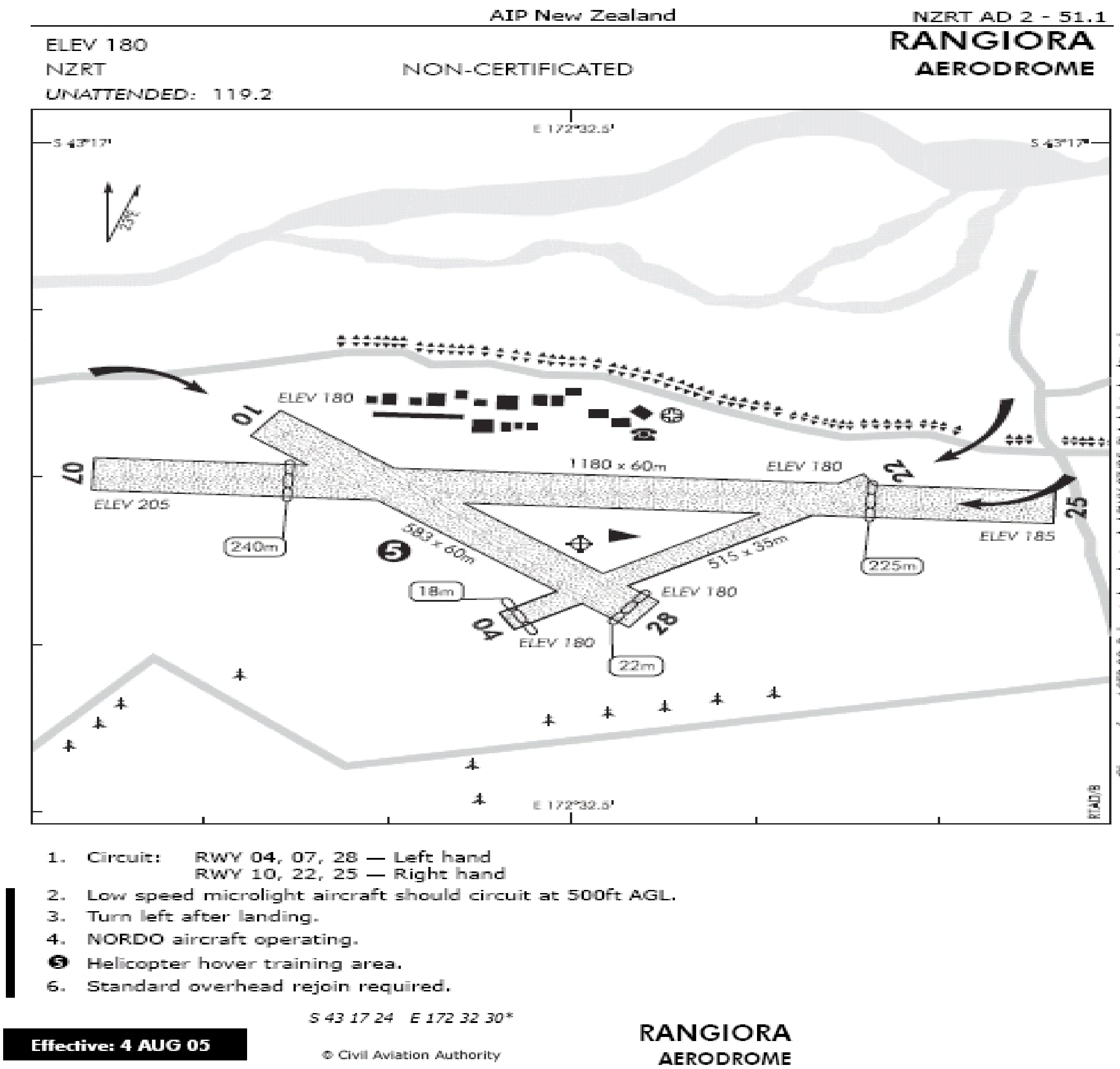
Ultralights (or any aircraft) may not enter **controlled airspace** or land at airfields within controlled airspace without clearance from ATC- this may be prearranged by telephone for NORDO aircraft or via radio for radio equipped aircraft.

Aircraft may not land at airfields in a **Mandatory Broadcast Zone** MBZ unless radio equipped or flying in loose formation with a radio equipped aircraft. Radio calls must be made prior to entering the MBZ and at the designated intervals.

NORDO aircraft may land at any **uncontrolled airfield**, exercising due care and lookout. Some uncontrolled aerodromes have a locally operated facility, a Universal Communications facility [UNICOM] which provides information on local conditions. Where such a facility is operating it is vital for NORDO aircraft to **maintain a careful lookout**, as other radio equipped aircraft operating in the area may not be as vigilant as they should.

All civilian airfields can be classified as public or private. Public airfields are usually owned by the local government body and landing permission is generally not required although it is always wise to check. Private airfields usually cannot be used without prior permission from the owner, except in an emergency, even then there may be problems with trespass. Landing and parking charges apply at many airfields.

There is much to be considered when planning a landing at an unfamiliar airfield or, indeed, a familiar airfield. The current landing charts from the Visual Flight Guide (AIP Section 4) and NOTAM should be fully consulted, particularly to check the circuit procedures and stated hazards.



For unlisted airfields, it is always wise to pre-check with the owner/operator about the airfield conditions. (It is too late to find out the surface has been softened by rain when you are up to the axles and about to tip over.)

Hazards

You must be aware of your aircraft's landing (and subsequent take-off) performance in normal, soft field and short field conditions and you should perform a safety audit of the destination and alternate airfields for length, slope, surface condition, approach and go-around hazards, stock and wildlife hazards, tyre and wheel hazards, and any commonly occurring micro-meteorological hazards.

Check runway directions and expected wind conditions and be wary of airfields with single runways= crosswind conditions may be beyond your aircraft's capability. Be particularly wary of airfields with 'one-way' strips, they are extremely tricky, if not outright dangerous, for those not familiar with the atmospheric conditions which could exist.

The availability, and location, of suitable fuel should be checked.

Remember, just because your assessment concludes that you can safely land at a particular airfield it does not guarantee that you will be able to take-off safely.

Local knowledge

Local pilots are a valuable resource when planning flights into unfamiliar territory or airstrips. They know the best way to do things- the easiest routes, easily identifiable reference points, places to avoid, local procedures, and where that rabbit hole is on the field. And they can provide weather reports from a microlight pilot's point of view. Make use of them- they are generally happy to help.

Route construction

The route you choose will depend a lot on the capabilities of you as a pilot and the facilities, equipment and performance of your aircraft.

- If you have a **low performance** aircraft with limited endurance and no radio, you will tend to choose a route that sticks to class G airspace and uses VFR transit lanes around controlled airspace. Your route will be a series of shorter legs (limited by endurance) with fuel availability at each waypoint being important. If there is any wind, you will need to consider the terrain and chose a route that minimises the adverse effects of wind (headwinds, turbulence). You would also choose a route with plenty of options of alternate airfields or land-out options.
- If you have a **higher performance** aircraft with good endurance and radio and transponder equipped, your route options will be less restricted. Longer legs, using controlled airspace when required, with less consideration of wind.

But in both cases the weather- particularly **incoming fronts, cloudbase and wind-** are an important factor in your final choice of route, and may force a change of plans enroute- **be prepared**.

Having decided a destination the first step is a rough calculation to ascertain

- the track – the path over the ground;
- the 'distance to run' from your departure point;
- the approximate sector time
- and the viability of the proposed flight.

The charts needed are a current VNCs.

Route construction is often done the day before planned departure, or even earlier if an extensive cross country flight is planned.

With a soft pencil and a rule draw a preliminary line on the VNC between your departure and destination – you may have to overlap charts– and then check along the line for areas to be avoided – 'tiger country' i.e. rough or heavily forested or hilly areas where there is a limited availability of open, cleared, flat land for an emergency landing. If possible avoid long stretches of featureless terrain and also terrain exceeding 3500 feet elevation.

Note any other airfields near the line.

Now decide which areas of terrain to avoid and find a suitable diversion around them. If that diversion takes you quite a distance from the direct line then so be it; it won't make that much difference to the total distance flown. If there are areas of scenic, or other, interest evident on the chart you might plan to overfly them even if it does makes a zigzag path.

Tracking around and beneath controlled airspace

Note all controlled airspace (boundaries and lower levels, transit lanes, danger and restricted areas, MBZs, MOAs and SPZs). You may elect to enter rather than go around/under controlled airspace, but ensure that you have the necessary equipment (VHF radio, possibly transponder) or prior clearance.

When planning to track near a CTR be aware that you must avoid incursion into controlled airspace without clearance from ATC. A VHF radio is advisable when planning to operate close to a CTR- if you do get caught between rising terrain and a lowering cloud base you can always call Air Traffic Control and request clearance to track through the edge of the

CTR because of deteriorating weather. ATC are always very helpful but unauthorised entry into the CTA or CTR (the dreaded 'violation of controlled airspace' or VCA) is a safety hazard and may earn a substantial fine.

Waypoint selection

You need to find suitable, i.e. readily recognisable, point locations or waypoints for monitoring flight progress and/or to mark the points of diversion and consequent turning points.
Suitable waypoints are

- airfields
- major road junctions
- small towns
- intersecting line features (road, rail, transmission lines)
- water features (lakes, rivers, coasts)
- distinctive hills, ridges, peaks
- microwave and radio towers

You may also see some highly visible linear features – roads, railways, transmission lines, rivers, beaches – that roughly parallel your intended track for a reasonable distance. Plan a track divergence to intercept and then follow such line features – and be aware that the 'Rules of the Road' require aircraft to track to the right of a line feature or when flying within a valley or any air traffic lane.
Mark all the turning points on the chart, joining them to form the route segments of the required track. These turning points will also be used as fuel consumption checkpoints. Generally speaking a route that provides the best visual fixes and reasonably short segments is the best option.
Measure the total track distance using the scale (in nautical miles) printed on the map or alternatively use the latitude graticule printed along the meridians, each mark is one minute of latitude or one nautical mile. The printed scale is easier to read and thus less prone to errors. You can buy a ruler scaled in nautical miles for use with VNCs and you might buy a protractor at the same time.
Divide the total track distance by the cruise speed to get an approximate total time required. If the total time required is greater than the known maximum sector time then the flight must be broken into two or more sectors, by introducing refuelling stops at appropriate distances. This probably necessitates replanning the waypoints so that one or more coincide with an airfield with assured and suitable fuel supplies. Replot the route if necessary.
If the total time required is less than the maximum sector time then the first cut plan for the route to be followed may be viable but we have not yet taken into account the effects of wind, which may be considerable and are covered in the next module.
Forecast weather and winds should be ascertained as close to the planned departure time as possible but it is advisable to obtain a preliminary weather forecast the evening before the flight. If a very long flight is planned it is advisable to watch the weather patterns for a few days prior to the trip. Any NOTAM applicable to the area in which you intend to operate should also be obtained at that time.

Plotting the route on a chart

Shown above is the route we plan to fly from an airstrip on a rural property – Koputaroa– to an airfield at Feilding (Taonui). The direct track is shown as a solid red line, with a track distance of 23NM measured against the tick-marks on vertical lines of longitude.
Looking at the terrain, the track presents no problem- the surrounding terrain is flat, Feilding is the highest point at 214 ft elevation! The high country to the east (2800ft) is well clear of our track. Provided there is not a strong easterly wind (unusual), there should be be no turbulence form the hills. We should be wary of strong westerly winds (common), as we are close to the coast- but provided we maintain a reasonable height AGL we should remain above any low level turbulence. A westerly wind may have a significant affect on our drift, so our heading may have to be somewhat west of the desired track.
But we have a problem with airspace! This is a complicated piece of airspace, so it is important to study it carefully.

- Koputaroa is within the **Manawatu CFZ** which is from the surface to the lower level of class C airspace, frequency 122.6. The border is shown by a chain of diamonds, the details in a blue box just west of the Koputaroa airfield. We are OK to fly in this CFZ, we just need to maintain a watch on that frequency.
- Koputaroa is beneath **class C transponder mandatory airspace** with a lower level of 3500ft. The border is marked by the purple lines, with details in purple to the east of Shannon. We need to keep below 3500ft.

- There is a **low flying area L366** just north of the field- we should climb to at least 500ft before transitting this area.
- The lower level of the **class C TM airspace** drops to 1500ft just south of Opiki. We need to keep below it.
- And around Karere we hit the **Palmerston North Control Zone** from the surface to 1500ft, transponder mandatory, frequency 120.6. We don't want to go through a busy control zone, so we will have to alter our track.
- Closer to Feilding airfield, we clear the Palmerston North CTR, and are back under **class C TM airspace** with a lower level of 1500ft.
- Fielding is also within the **Feilding CFZ**, surface to 1500ft, frequency 124.1. There is also a **special message 6** advising transitting traffic to avoid the Feilding active circuit- but that doesn't apply to us.
- The western end of the Palmerston North CTR has the **Oroua VFR Transit Lane T354**, surface to 1000ft during daylight hours, frequency 124.1, with **special message 17-** transponder in mode A and C if fitted, and nav/landing lights on if fitted. T354 also shows arrows indicating to track on the right side if the transit lane to avoid opposing traffic.
- There are also quite a few **red aircraft symbols** dotted around the area, indicating high density of VFR traffic. We need to maintain a good visual lookout.

The chart above shows our amended track to avoid controlled airspace and make use of T354 VFR Transit Lane. The short flight is effectively broken into 3 segments as follows...

FLIGHT PLAN	Koputaroa-Feilding						
Aircraft:	ZK-XYZ						
Cruise:	50	kts					
Fuel burn:	15	l/hr					
Leg	Altitude	Radio	Track	Distance (NM)	Time	Fuel	Notes
Koputaroa-Mangawhata	500-1500	122.6 Manawatu traffic	020T	11			VFR traffic
T354 Oroua transit lane	Below 1000	124.1 Oroua traffic	river	8			West of river, landing lights on
Awahuri-Feilding	Below 1500	124.1 Feilding traffic	080T	5			

Note that flying over flat terrain such as this at low level (100ft) with few spot features can be very disorienting! For this flight a useful plan in case you get lost would be to

- track due north from Koputaroa until you see the transmission lines
- follow the transmission lines until you intercept the river boundary for T354
- track up the river (on your right) to Feilding township
- follow the railway line to Feilding airfield

Checking minimum safe altitude

We now have to decide the minimum altitude at which each segment can be safely flown. In this example the decision is quite easy- the terrain is flat, less than 100ft AMSL, the only obstructions along the track are the transmission lines, the nearest hills are well east of track, and we have a ceiling of 1000ft in the Oroua transit lane. Given minimum altitude is 500ft AGL, flying at 800 AMSL will give us clearance above and below.

If this was more hilly/mountainous terrain, minimum safe altitude should take into account any ridges that need to be crossed, any significant peaks adjacent to track, and any obstructions (cables, aerials, transmission lines) that may be difficult to see in marginal conditions. 500ft clearance is the minimum you should plan for unless the visibility and conditions are very good.

The preliminary flight plan

We have now accumulated the non-variable part of our flight plan (ie assuming nil wind). We can calculate leg times and fuel burn to come up with a preliminary flight plan. Assuming 50kts and 15 l/hr out plan would look like this:

FLIGHT PLAN	Koputaroa-Feilding						
Aircraft:	ZK-XYZ						
Cruise:	50	kts					
Fuel burn:	15	l/hr					
Leg	Altitude	Radio	Track	Distance (NM)	Time	Fuel	Notes
Koputaroa-Mangawhata	500-1500 (800)	122.6 Manawatu traffic	020T	11	13	3	VFR traffic
T354 Oroua transit lane	Below 1000 (800)	124.1 Oroua traffic	river	8	10	2	West of river, landing lights on
Awahuri-Feilding	Below 1500 (800)	124.1 Feilding traffic	080T	5	6	2	
			TOTALS	24	29	7	

Before we can proceed further we must:

- Ascertain the **weather** and the wind that are forecast for the period of our planned flight.
- Check for **NOTAM** which may affect us.
- Determine the time for **Evening Civil Twilight (ECT)** if our flight is planned for late in the day.

Obtaining weather forecasts, NOTAM, ECT

Weather forecasts

The official source of aviation weather forecasts is **MetFlight-GA**. This is a user pays service, requiring you to log in with a user id and password. These are issued to you by X-TEAM when you first enter the system. Details of how to access weather from MetFlight-GA and interpret the information are detailed in the Meteorology section of the Training Manual.

NOTAM

The official source of NOTAM is the ANS website. This is a free service, but you need to log on with a user id and password to access the information. Once logged in select **Area Pre-flight Briefing** to get to this page-

Click on the areas for which you require a briefing, check **NOTAM** and **ATIS** (if you want the current terminal weather) and click on **SUBMIT**- your briefing will appear in a few seconds.

You can also select the **Specific Pre-Flight Briefing** option for a briefing tailored to only those airfields and areas you will be flying to.

Note that these pages also have a link to MetFlight-GA. This is a quick way to get your NOTAM and weather briefings in one hit.

You should always check NOTAM before a cross-country flight. There are often cases where a pilot flies into familiar territory and airfields without checking NOTAM, only to be caught out with an unexpected runway closure or event that he should have been aware of.

ECT

Twilight tables are also available off the Airways IFIS website. Select *'Planning info/Twilight Tables* and then which table option you require- the Interactive option is good.

Note that the values for MCT and ECT are in UTC format- you need to add 8 hours to get local time.

The next module deals with the effect of wind on our flight plan.

THE EFFECT OF WIND

Module content

- Vectors and the wind triangle
- Estimating heading and ground speed
- Navigation calculators

An aircraft in flight is airborne and subject to the movement of the air mass in relation to the surface i.e. the wind. The relatively low cruising speed of light aircraft makes them particularly affected by the wind velocity and consequently the calculation of the wind effect on aircraft velocity relative to the ground is a major part of light aircraft flight planning and navigation.

The two questions you need to know the answers to are:

- Are we going to have a **tail or head wind** and how much?
- Are we going to **drift left or right** and how much?

If you have a reasonable (ie ballpark) answer for those then you are well on the way to planning your flight time and fuel requirements.

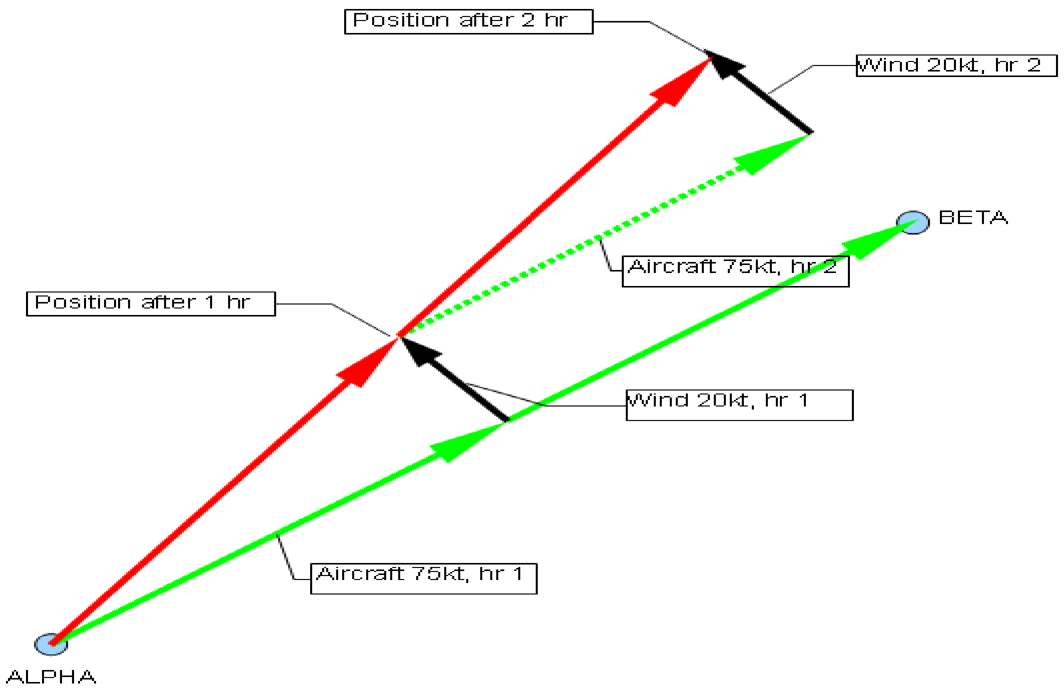
Vectors and the wind triangle

The effect of wind on an aircraft's movement is most easily understood and solved by **vectors and vector triangles**.

A vector is an arrow with length proportional to the **magnitude** of some quantity, pointed in the **direction** it is acting. In our case where we want to determine the effect on wind on our aircraft, we use **velocity** vectors where the magnitude represents wind or aircraft speed, and direction represents their directions.

We know that an aircraft in flight is airborne and consequently both the path it projects over the ground and its speed relative to the ground are the resultant of the aircraft velocity and the wind velocity.

For example waypoint Beta is 150 nautical miles north-east (045T) of waypoint Alpha and an aircraft departs overhead Alpha for Beta, maintaining a heading of 045T while cruising at 75 knots. At the time the wind velocity at the cruise altitude is 135°/20 knots i.e. the 20 knot wind is coming from the south-east. Where will the aircraft be after two hours flight? Certainly not over point B as it will have moved 150 nm north-east within the air mass while the air mass has moved 40 miles north-west. So we might surmise that after two hours flight its position will be about 40 nm north-west of point B and this is shown below. The aircraft has drifted from its intended path or track over the ground and the **track made good** is about 15° to the left of the required track.



GREEN- nil wind track
RED- resultant track with wind

We should note that, relative to the aircraft's course, the wind velocity normally has both a **crosswind component** and a **headwind or tailwind component**. Both these will affect the aircraft's speed relative to the surface – the ground speed. For the head or tailwind component that is easily understood- it is blowing with or against you. The crosswind effect is less intuitive, but it is making your aircraft cover more ground- albeit in the wrong direction- so your ground speed is generally increased.

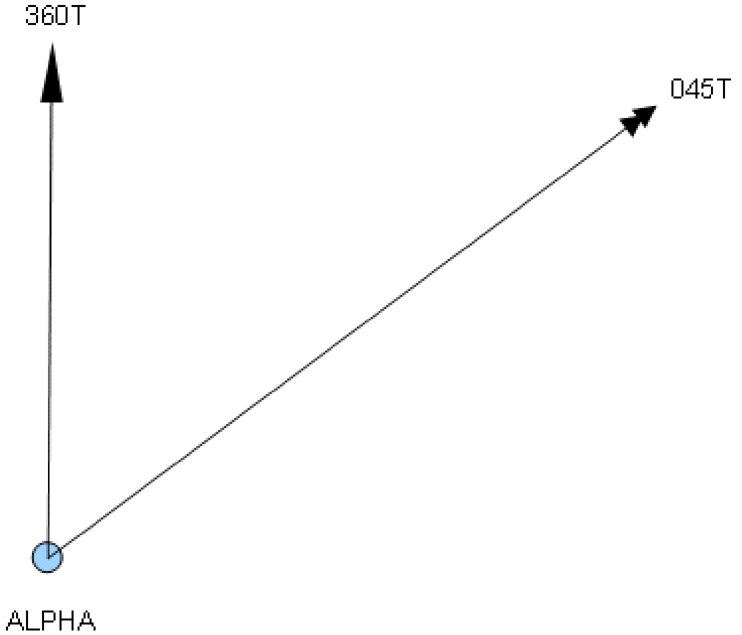
The wind triangle

If we want to track over the direct route from Alpha to Beta we will have to determine the heading to fly that will provide the necessary crosswind correction angle to keep us on direct track. Remember that velocity vectors have both speed and direction. In the wind triangle we have some knowns, and two unknowns we want to determine.

Wind triangle		
Vector	**Magnitude**	**Direction**
Wind	Known	Known
Aircraft	Known (airspeed)	**Unknown** (heading)
Resultant	**Unknown** (groundspeed)	Known (track)

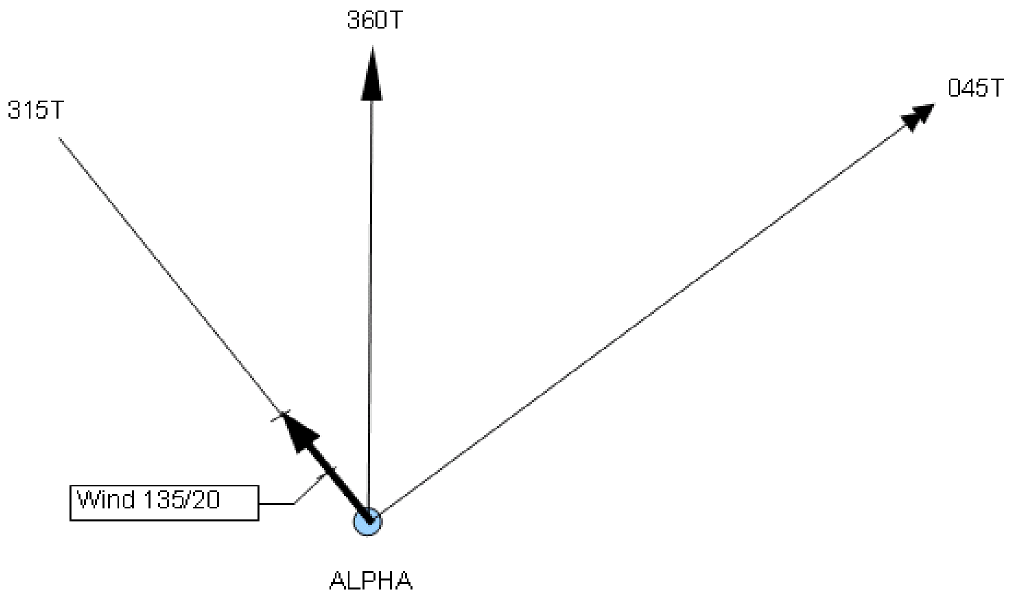
We can determine the two unknowns, the heading and the ground speed, by plotting scaled vectors on paper. You will need some drawing instruments, a protractor and ruler, but a pair of compasses or dividers can be useful:

- First draw a vertical line labelled true north and mark a position on the line as waypoint Alpha.
- Using a protractor centred on Alpha and aligned with true north, mark the bearing to waypoint Beta e.g. from the above, 045° true. Rule a line of appropriate length from Alpha through the bearing, marking it with two arrows to indicate the track direction and annotate that bearing.

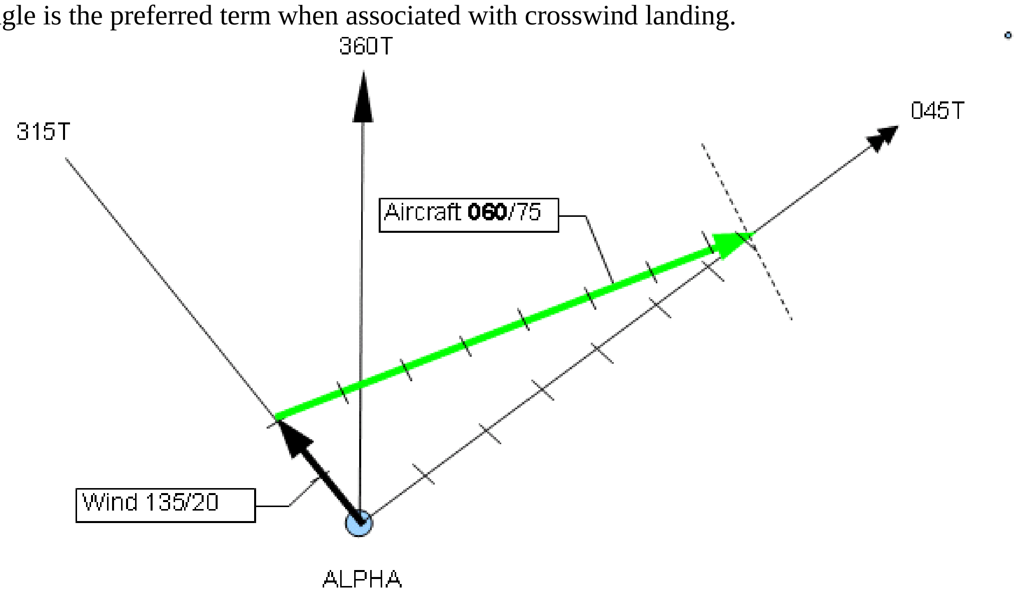


Wind velocity is given as the direction the wind is coming from and we need to plot the direction it is moving to, the reciprocal bearing. The reciprocal is the stated direction ±180°. Using a protractor centred on Alpha and aligned with true north, mark the reciprocal wind bearing, 135° ±180° = 315° true.

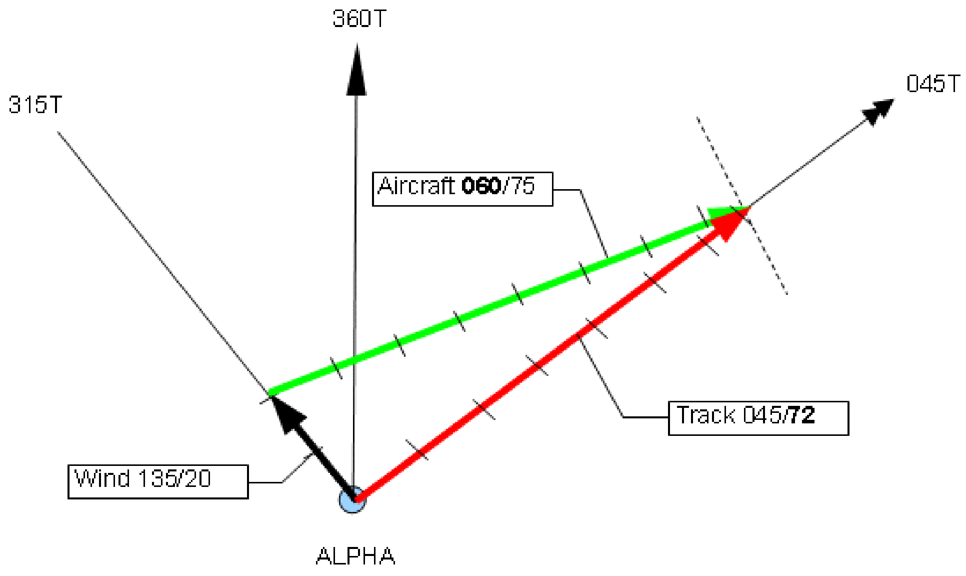
- Rule a line of appropriate length from Alpha through the wind bearing mark. Decide the scale to be used and mark off a distance along that line that equals the air movement during one hour, i.e. 20 nm (20 knots wind speed). Annotate the wind velocity vector 135/20 knots.



- Using the scale, open up the dividers or compasses to the distance equalling the air distance the aircraft travels in one hour, i.e. 75 nm at the cruise airspeed of 75 knots. With one divider/compass point on the arrow of the wind vector, mark the track line with the other divider/compass point. Or just use the ruler to accomplish the same task.
- Draw a line connecting those two points, marking it with an arrow to represent the heading vector. Its orientation with true north is the heading (060°T) and its length is the TAS. **Thus we have the first unknown, the direction in which to point the aircraft**. Annotate the heading (060°T) and TAS (75 kn).
- Also note the wind correction angle [WCA], the difference between the track and the heading, 15°; and that the drift will be to the left, port drift if you are of a nautical bent. The wind correction angle is the angular difference between the required track and the heading, intended to ensure that the track made good will equate with the required track. Note that the terms 'crab angle' and 'drift angle' are very often used in lieu of 'wind correction angle' but the latter term is more precise, crab angle and drift angle do have slightly different meanings or associations. Drift angle is measured in flight, being the angle between the heading and the track made good. Crab angle is the preferred term when associated with crosswind landing.



- Now measure the distance between Alpha and the tip of the aircraft vector, which is the distance (72 nm) moved over the ground during one hour – **the second unknown, the ground speed**. Annotate the ground speed (72 kn) adjacent to the bearing.



We can now calculate the sector flight time from overhead Alpha to overhead Beta; this time is called the estimated time enroute or ETE.

- ETE = Distance (nm) / ground speed (kn = 150/72 = **2:05**.

It is interesting to note that even though the wind was a full crosswind the ground speed is less than TAS and thus the ETE is a bit greater than you may have expected. This is because the heading of 060° would now include a small headwind component.

It may be thought that if an out-and-return trip is flown, where the wind is directly aligned with the required track, the headwind encountered in one direction will be offset by the tailwind in the reverse direction, and thus the total flight time will be equivalent to that in nil wind conditions. Not so, the greater the wind speed the greater the flight time on an out-and-return flight, no matter what the wind direction. Imagine a flight Alpha–Beta–Alpha in nil wind conditions. The ground speed on both the outward and return legs would equal the TAS (75 kn) and each leg would take 120 minutes for a total flight time of 240 minutes. Now let's factor in a 25 knot north-east wind. The ground speed on the outward leg would be 50 kn and the ETI would be 180 minutes, whereas the ground speed on the return leg would be 100 kn and the ETI 90 minutes for a total flight time of 270 minutes.'

Plotting the wind vector triangle is the most accurate method for ascertaining heading and ground speed but there are two other methods which are quite accurate enough for light aircraft cross country navigation.

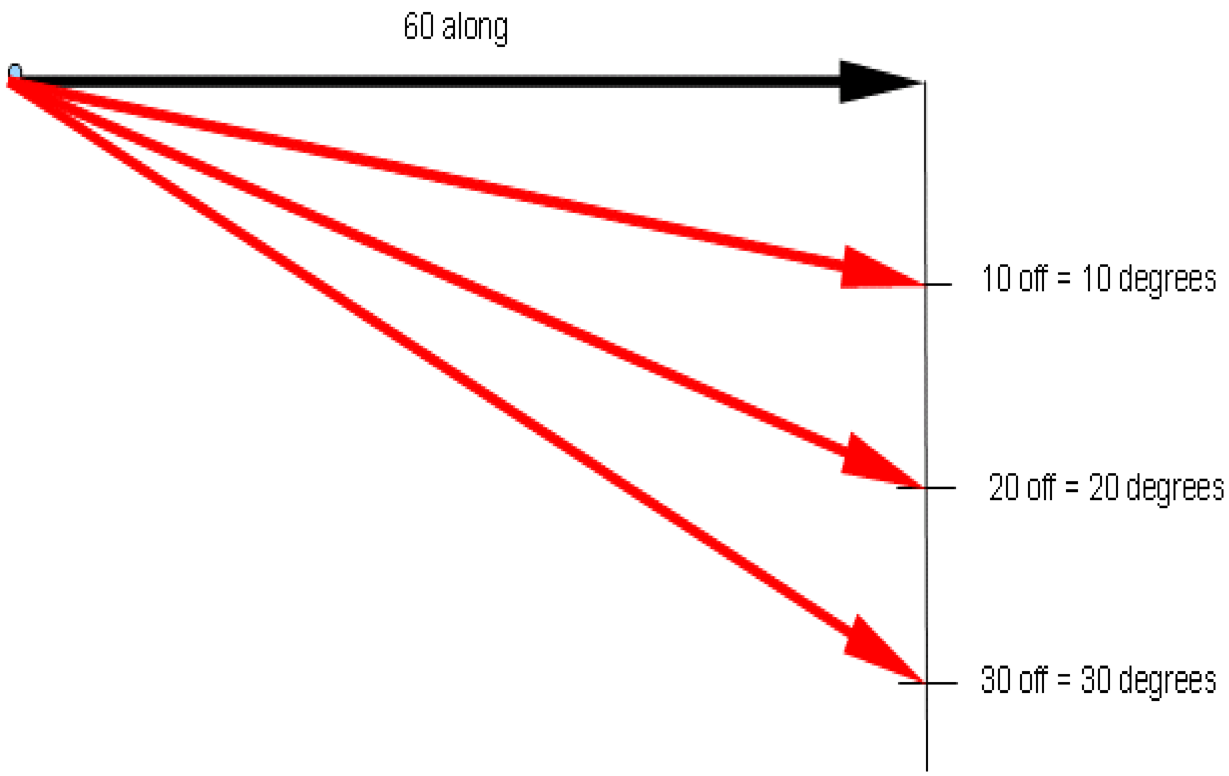
Estimating heading & ground speed

The question with wind triangle plots is that you start with the assumptions that the forecast wind velocity is accurate, the aircraft's magnetic compass is accurate and the pilot will maintain a constant heading in flight. However there will be considerable variability in each so there is no reason to try for absolute accuracy in the initial calculation of heading, ground speed and ETI.

We can introduce a few shortcuts to the process by using some simple mental arithmetic to estimate the crosswind and headwind/tailwind components of the wind velocity relative to the required track, rather than plotting the wind triangle. Even so it is wise to become familiar with plotting the wind triangle as the experience makes it much easier to mentally picture the relationship between the vectors, thus avoiding flying entirely in the wrong direction, which is remarkably easy to do.

The 1-in-60 rule

The 1-in-60 rule states that **a 1 degree angle is approximately 1 unit offset for every 60 units along**. For example, if you are 5 degrees off heading, you will be approximately 5NM off track after travelling 60NM. This rule is accurate enough up to about 45 degrees.

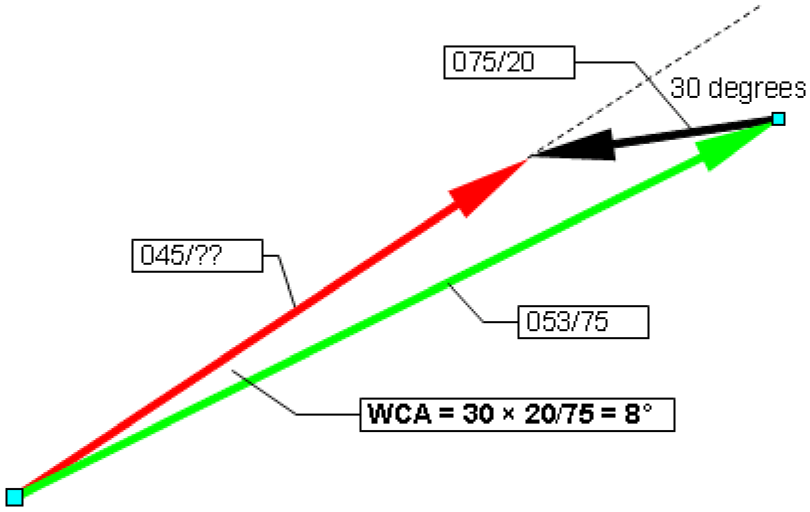


Estimating WCA

WCA = relative angle [up to 60 max] x wind speed / TAS

Example:

- track = 045°
- TAS = 75 kn
- w/v = 075/20 kn
- relative angle = 30
- WCA = 30 × 20/75 = 8°



And remember that the wind correction is applied in the direction the wind is coming from so that the aircraft crabs along the required track.

Estimating groundspeed

To estimate the ground speed **deduct the (acute) angle at which the wind meets the track from 115 (for angles up to 60°, use 105 for greater angles) and apply that as a percentage of the wind speed**.

Groundspeed estimating			
	Example A	**Example B**	**Example C**
Track	045°	045°	045°
W/V	075/20	135/20	195/20
angle	**30**	**90**	**30**
Calc	**115 - 30 = 85**	**105 - 90 = 15**	**115 - 30 = 85**
Head/tail wind	85% of 20 = **17 knots headwind**	15% of 20 = **3 knots headwind**	85% of 20 = **17 knots tailwind**

Subtract the result from TAS if wind coming from ahead to abeam, otherwise add.
You may think it wrong that if the wind is at 90° to the track (example B) the ground speed calculation will still come up with a headwind component. This is because you will have to crab into wind to hold track, so there will be a headwind component on you, thus slowing your ground speed.
All the techniques described are not ultra precise but they are quite OK for all normal cross country navigation.

Navigation calculators

There are several 'do everything' circular slide rules, or 'whiz wheels', marketed for aircraft flight planning usage. These navigational computers also incorporate a wind disc for the solution of the wind triangle. They too find the wind triangle solution by breaking the wind velocity into the crosswind/headwind components, rather than plotting a full wind vector triangle. You will find them very useful on the ground but some can be difficult to read and adjust in a light aircraft, particularly in an open cockpit. You may have enough difficulty just handling the chart, the flight plan notes and a pencil.
The **Jeppesen CR2** is OK and will fit into your pocket – together with a small folding rule – and can be operated with one hand for time and distance calculations.
E6-B calculations is now a generic term for all the calculations associated with tracks, TAS, wind velocities, headings, groundspeeds, density altitude, time, fuel, weight and balance and so on. The term derives from the model number of an older instrument, consisting of a pair of parallel rulers incorporating a rotatable compass rose, which was designed for laying out plots and wind triangles on charts.
There are hand held E6-B calculators or computers which do much the same job as the whiz wheels. There are also E6-B software utilities for iPads, smartphones and tablets readily available for about US$20 – or possibly as freeware.
However for basic map-following pilotage in Mongolian, where there are plenty of land features to monitor track and drift drift, the simple estimates for WCA and groundspeed are generally sufficient for flight planning, where the most important issue is the effect of wind on groundspeed and therefore flight time and fuel burn.

FLIGHT PLAN COMPLETION

Module content

- Weather check
- Updating your flight plan

At this stage of your flight planning, you will have completed your initial flight plan- perhaps a day or so ahead, or even more for a significant trip with many legs. You will have completed the following steps- mostly related to things that do not change from day to day (ie all but the weather):

- **Initial route plan-** identifying the preferred route and major waypoints along your route (Departure, intermediate stops, destination).
- **Airfield and airspace check-** modifying the preferred route to accommodate airspace restrictions, identifying alternate airfields and significant waypoints to aid with flight planning and monitoring.
- **NOTAM check-** information re airfields and airspace that may impact on your plans, and modifying your plans if necessary.
- **Plotted the planned route** on the charts.
- For **each leg of the route**, noted the track, distance, altitudes and frequencies, and flight time and fuel burn assuming nil wind.
- **MCT and ECT check-** to make sure you can complete the flight in daylight.
- Assembled all the necessary **documents-** navigation charts, landing charts, flight plan.

Now all that is required is to get the latest current and forecast weather, update your calculations for heading, groundspeed, time and fuel burn for each leg taking into account the expected weather conditions enroute.

Weather check

Gather weather information using official (MetFlight-GA) and unofficial sources (MetVUW, pilot reports, trusted pilots at your waypoints and destination). Together these should give you a reasonable picture of the weather to expect enroute and at your destination.

It is also a good time to do a **sanity check-**

- Does the expected weather require me to change my plans?
- Incoming fronts?**-** Am I going to face changing conditions, with wind and rain?
- Wind?**-** Effects on flight time, turbulence, change of route to remain upwind in high country?
- Cloudbase?**-** Adequate clearance from terrain?
- Dewpoint?**-** Very important for early morning flights**-** the ambient temperature will continue to drop until the sun is well up and warming the ground- caution fog forming.

It can be psychologically difficult to change your plans, particularly following detailed planning and preparation, and perhaps days of excitement as you mentally go through the flight. But it is important that you step back and review the go/nogo decision in a rational manner. Put aside the promises you may have made, the expectations of your passengers and those at your destination. Clear GO and NOGO conditions are relatively easy, but under marginal conditions you may have a bias to go ahead as planned.

It is far better to be on the ground, looking at a clear blue sky and saying you wished you has said 'GO", than fighting through a black sky wishing you has said 'NOGO'.

Updating your flight plan

Using the latest current and forecast winds, update your flight plan. **For each leg** update following:

- **Wind correction angle**. Use the method described in the Effect of Wind module to estimate the WCA to keep you on track. This need only be approximate, as you will be flying in pilotage mode with reference to ground, and able to make adjustments to keep on track.
- **Groundspeed**. Use the method described in the Effect of Wind module to estimate your groundspeed. Do this with some care (particularly making sure you properly ADD a tailwind component or SUBTRACT a headwind component), as these calculations are important for flight time and fuel burn.
- **Flight time (ETE)**. Leg distance divided by groundspeed. Convert to minutes of flight time, as most legs will be less than 1 hour.

- **Fuel burn**. Flight time times fuel burn. It is also useful to show **fuel remaining** after each leg so you can easily see fuel reserve and when to plan your refuelling.

Bear in mind is that normal atmospheric turbulence ensures that the wind velocities experienced as flight progresses will vary considerably from those expected or forecast, particularly in the friction layer, so there is not much point in the pilot of a light aircraft flying VFR in Class G trying to be absolutely precise in determining headings and sector times.

Finally, **convert all your track bearings to degrees Magnetic**. Bearing taken directly off charts are in degrees True, but in the air your compass will indicate Magnetic. Apply the **Variation** from your charts to these bearings. For Mongolian, variation is East (negative)- subtract it from the True bearing to get Magnetic. **East least, West best**.

FLIGHT SAFETY AUDIT

Module content

- Being prepared for an emergency
- Flight fitness
- Planning and equipment check list

Before departure you should determine if your own physical and mental condition is conducive to safe flight, check that all navigation planning, navigation equipment and aircraft equipment requirements have been met and, finally, lodge your flight plan – in the form of a Flight Note (see below) – with a responsible person.

Being prepared for an emergency

There is **always** a possibility of an enroute engine problem, or other event, necessitating an off-airfield landing. A reasonable knowledge is required of the procedures associated with such incidents, particularly those occurring in remote areas. Ensure you are familiar with the operation of your ELT/PLB, and are appropriately equipped for your flight.

Before departure it is certainly wise, if not mandatory, to leave enough information with a responsible person that, should you fail to check in with them by an agreed time, a telephone ring around can be initiated. If that is unsuccessful the **Rescue Coordination Centre [RCC]** can be notified. RCC will attempt to make radio or telephone contact with the missing pilot, and initiate a search that uses your planned track as a starting point, while at the same time monitoring the 406MHz SARSAT for a distress signal.

Flight Fitness

The next check is a personal one, determining if YOU are safe to fly. A mnemonic checklist has been developed for that purpose.

The "IMSAFE" checklist

- **Illness**- Do I have an illness or any symptoms of an illness?
- **Medication** -Have I been taking prescription or over-the-counter drugs?
- **Stress** - Am I under psychological pressure from the job? Worried about financial matters, health problems or family discord?
- **Alcohol** - Have I been consuming alcohol within eight hours? Within 24 hours?
- **Fatigue** - Am I tired and not adequately rested?
- **Eating and drinking** - Am I adequately nourished and not dehydrated?

See also the Human Factors section of the X-TEAM Training Manual.

Planning and equipment check list

It is advisable to run through a flight planning, navigation equipment and aircraft equipment check list to ensure that all requirements have been covered:

- Have I established the **safest route and minimum safe altitude** avoiding high ground, tiger country, hazards, restricted areas & CTA/CTR?
- Have I double checked that all **magnetic bearings and distances** on the flight plan have been measured correctly?
- Have I checked the locations and the suitability of **refuelling stops, of the destination airfield and of alternate landing areas**?

- Have I checked **airfield details** in the VFG? For airfields not listed in VFG have I checked the airfield condition, approach and departure limitations/obstructions with the owner/operator and is my skill level sufficient to safely land and take-off at those airfields?
- Have I checked the enroute, destination and alternates **weather**, cloud base and visibility (ARFOR, TAFs, METARS and surface chart) and **NOTAM** (ADs, ALAs and restricted areas)?
- Have I left a **Flight Note**, showing the itinerary, with a responsible person who knows what action to take if I fail to check in by the agreed time?
- Have I checked that **watch, compass, ASI and altimeter function OK**?
- Should I be equipped with a functional **VHF transceiver** and if so have I noted/loaded all the required frequencies?
- Should I be equipped with a **406MHz PLB/ELT**? **All flights beyond 10NM must carry an ELT/PLB**
- Should I be equipped with **lifejackets**? And if on a leg over water, **wear them!**
- Have I **back-up batteries** for handheld equipment?
- Am I wearing **suitable clothing** for surface conditions, in case of an unplanned landing?
- Should there be a **First Aid kit** in the aircraft?
- Should I take an extra supply of **prescribed medication**?
- Is there an adequate **water supply** in the aircraft?
- Is **tie-down gear** loaded?
- Have I physically confirmed the actual **fuel load provides a reasonable margin**, on top of the flight plan needs including the reserve?
- Has the the fuel in the tanks been **physically checked** for quality and water or other contamination?
- Have I checked aircraft **weight & balance** with everything and everyone loaded?

AIRMANSHIP AND FLIGHT DISCIPLINE

Module content

- What is airmanship?
- Risk management
- Situation awareness
- Rules, regulations and commonsense
- Self discipline
- Personal operating procedures

Good airmanship is that indefinable something, perhaps just a state of mind, that separates the superior airman/airwoman from the average: it is not a measure of skill or technique, rather it is a measure of a person's awareness of the aircraft and its flight environment and of her/his own capabilities and behavioural characteristics, combined with good judgement, wise decision making and a high sense of self-discipline.

What is airmanship?

The definition is somewhat indistinct; with the introduction of computerised cockpit systems it is certainly more complex now than 50 years ago. Some might say it involves pilot proficiency, flight discipline, aircraft system and airworthiness knowledge, skill in resource management plus being fully cognizant of every situation and exercising excellent judgement. Someone recently did say – in relation to the management of airline transport aircraft – airmanship is "the ability to act wisely in the conduct of flight operations under difficult conditions".

Just as the term 'seamanship' implies a full appreciation of surface wave action and sea movement so does 'airmanship' imply a full appreciation of atmospheric waves, eddies and turbulence.

Airmanship is the cornerstone of pilot competency. Competency has been defined as the combination of knowledge, skills and attitude required to perform a task well – or to operate an aircraft safely and in all foreseeable situations. A flight operation, even in the most basic low momentum ultralight, is a complex interaction of pilot, machine, practical physics, airspace structures, traffic, weather, planning and risk; and when each and every flight is undertaken it is not only the aircraft which should be airworthy, the total environment – airframe, engine, pilot, atmospheric conditions and flight planning – should allow for the safe, successful conclusion of each operation. It is the perception – founded on the acquired underpinning knowledge – of the state of that total environment and its potential risks that provides the basis for good airmanship and safe, efficient, error free flight. Insufficient perception and insufficient self-discipline create a pilot at risk.

Ensuring engine and airframe airworthiness prior to flight is a prime component of airmanship; however – for the person accepting an aircraft she/he does not own/operate – airworthiness, unfortunately, is a matter of faith in the operator and in the maintenance record. Visual and operational pre-flight checks cannot assure airworthiness — the pilot does not know what is hidden under the skin or within the engine.

Risk management

Most recreational pilots, as with most general aviation pilots, accumulate only a few hours each year. About two thirds of recreational pilots fly less than 50 or 60 hours; perhaps such annual hours is enough to maintain physical flying skills learned at the ab initio flight school – if the pilot has established a program for self maintenance of that level of proficiency – but maybe not enough to maintain a high level of cognitive skills, for example situational awareness, judgement and action formulation. In addition, once having completed flight theory studies sufficient to pass the basic aeronautical knowledge test and achieve the Pilot Certificate, it seems that many, perhaps most, pilots leave it at that, failing to expand their knowledge by further in-depth studies of flight dynamics. Possibly because it involves sometimes difficult detail rather than the broad brush approach of the flight school and perhaps assuming that such knowledge will be expanded through consequent flight experience, also assuming, I guess, that they will survive each learning experience.

However many pilots are just continually repeating the same flight experience — each year is the same as the last — so all they accumulate is a repetition of one year's experience. They have no program of deliberately accumulating advanced knowledge or skills nor have they really absorbed the safety basics which should have been drummed into them over the years — never turn back following EFATO; always maintain a safe airspeed; if the engine has been misbehaving never take-off until the problem is identified and fixed; if the engine goes sick in flight don't try to make it back to base, land ASAP; don't continue into marginal conditions - turn back, and so on.

So a safety problem exists with pilots. Many are just not ensuring that they accumulate adequate post-Certificate knowledge and skills. In short they never really learn much about flight dynamics [and some of their accumulated beliefs are dangerously false] and they lack other pertinent knowledge and worse, they are just not listening or hearing.

The sound pilot must understand how the environment parts relate and interact with each other, and judge the likely consequences of any action, deliberate non-action or random event. A systematic approach to continuing improvement in airmanship, plus ability for self-appraisal, is necessary to achieve that understanding. The Flight Manual or Pilot's Operating Handbook for the aircraft model being flown must be fully understood, and the content recollectable when needed in an emergency. Every flight should be conducted correctly and precisely, using procedures appropriate to the airspace class and without taking shortcuts, even if just a couple of circuits and landings are contemplated.

Pilots should be aware that fatigue, anxiety, emotional state – or flying an aircraft which stretches their skill level or just flying an aeroplane they don't like – will affect perception and good judgement. See the "I'M SAFE" checklist. Most studies of aircraft accidents or incidents reveal not a single cause but a series of inter-related events or actions that, being allowed to progress without appropriate intervention from someone, lead to an unplanned termination of the flight operation.

U.S. Navy pilot once wrote "In aviation you very rarely get your head bitten off by a tiger – you usually get nibbled to death by ducks." However U.S. Navy pilots are well trained, well informed, self-disciplined individuals who do not expose themselves to those situations where the tiger WILL eventually bite your head off.

The gliding community demonstrated many years ago that there were two main cyclic periods (for them) where people were accident prone. This was about the 100 hour mark, where pilots were beginning to think they were immortal, and about 200 – 250 hours when they were sure they were: being survivors of the incidents of the first period.

Dr Rob Lee, the then Director of the Australian Bureau of Air Safety Investigation, wrote in 1998: "Over 40 years of investigation of General Aviation accidents by BASI and its predecessors clearly shows that while the immediate circumstances of each accident may well be unique, the underlying factors are always drawn from the same disturbingly familiar cluster — pre-flight preparation and planning, decision making, perception, judgement, fuel management and handling skills". A preliminary study of the factors contributing to fatal general aviation accidents in Australia for the ten years up to 2000 showed that flight planning was a factor in 38% of the accidents, aircraft handling errors in 30% and fuel starvation or exhaustion in 10%.

Situation awareness

Being situationally aware means to be fully cognisant of the big picture, at all times, by continually collecting and judging information, from sources inside and outside the cockpit. In flight a pilot has to be several minutes ahead of the aircraft, not several seconds behind it – to perceive what's going on and be able to impose sound judgement on every change, from a minor distraction to a major in-flight emergency. In an emergency situation stress may build rapidly and the pilot will tend to unconsciously focus on a very few aspects of the situation without noticing that other aspects are degrading – airspeed or attitude for example. Good handling of any unusual situation – particularly the first major emergency – provides a basis for confidence in abilities. Poor handling of an emergency will undermine confidence.

There is much written on the ways to improve situation awareness but it probably boils down to a few basics: Assimilate an adequate knowledge base. To enable appropriate judgements and manage your errors you must have sufficient underpinning knowledge of all relative aspects of flight and of the aircraft you are flying.

Plan well in advance with a properly researched flight plan. Pre-flight planning may start days before a flight. Even local flying should be preceded by looking at a met forecast the evening before – to compare against the conditions you find and how the sky really looks. You must know the aircraft's take-off and landing capability in the existing airfield environment.

Continually monitor flight progress against that plan and re-evaluate the plan.

Develop and use a scanning technique that takes in engine instrument indications, flight instrument indications, aircraft heading, flight path (60° left, ahead, 60° right, above, below), time, map and ground. Develop a scanning pattern that covers everything without becoming superficial but also allows time to be allocated to individual scan segments according to your perceived needs.

Project ahead and rehearse your actions – for example:

- "The next checkpoint will be in sight in ..."
- "If the next checkpoint doesn't appear as scheduled I will ..."
- "If the cloud is not as high as it appears or there is more of it than there appears I will ..."
- "If another aircraft appears on a straight-in approach I will ..."
- "If the engine packs up soon after lift-off I will ..."
- "If the engine packs up above 200 feet I will ..."

Avoid locking on to a problem, a task – or, for instance, your intended landing point – for too long, don't keep your head in the office, keep the scan going, be aware of the relative position and movement of other traffic, hold the heading and fly the aeroplane – at a safe airspeed appropriate to current atmospheric conditions and your height above the surface.

When operating at, or in the vicinity of airfields, if you have a radio transceiver use it to communicate your position and intentions to other aircraft. Listen out for those key words that indicate other aircrafts' positions and intentions. Be aware that not all aircraft will be radio equipped and even those which are may not be listening out on the appropriate frequency.

Project ahead to plan safe and orderly traffic separation – most light aircraft mid-air collisions and near-misses occur in the vicinity of an airfield.

In short – be well informed, plan well in advance, fly to that plan, continually monitor flight progress, use a scanning technique, know where other aircraft are and their intentions, communicate when appropriate, project ahead and, above all, don't be distracted – fly the aeroplane and fly it at a safe speed and within your and the aircraft's performance limits.

Rules, regulations and commonsense

However not even the most experienced pilot, flying maximum hours every year, can judge the probability of all likely outcomes in any situation, expected or unexpected, and make the appropriate decisions. For that reason, among others, a system of regulations, rules, conventions, practices and standard procedures exists for recreational and sports aviation – and all other aviation communities – to follow. Once acquainted with them, these commonsense rules, procedures and practices generally provide an acceptable level of protection, but far too often pilots, and others – all of whom should know better – deliberately choose not to follow them and thus abandon that inherent protection.

Self discipline

The reason for choosing to ignore the established rules is usually to save time, or money, coupled with the belief that they will get away with it because 'it can't happen to me' or 'it'll be OK'. Sometimes, particularly when they flout the laws of physics or aerodynamics, it is either pure bravado or wanton disregard [i.e. plain stupidity] or maybe it is just lack of knowledge.

However there are – fortunately only a few – rogue pilots in the various aviation communities who believe that the rules, written or otherwise, are stupid or unnecessary and so determine to flout them. Such people thus ignore the trail of injury and death, stretching back over most of the 20th century, that formulated the rules and conventions. Each conscious infraction of those rules further dulls good judgement until crunch time finally arrives and, unfortunately, such rogues often take others with them. All pilots have a moral responsibility to inform a passenger, intending to fly with a person known to engage in illegal or doubtful activities (e.g. unauthorised low flying or inappropriate manoeuvres around the airfield), that flight with that person is inadvisable. If a person is known to consistently indulge in illegal flight then there is a responsibility to inform an appropriate authority — police, CAA, X-TEAM etc.

All pilots must occasionally ask themselves the question: Am I maintaining a fully disciplined approach to all flight and pre-flight procedures? And if not – why? Good airmanship cannot co-exist with poor discipline; a self evident truth is that a pilot lacking the appropriate self-discipline is an accident in preparation. Discipline overrides panic and reinforces the ability to maintain/regain control of the aircraft when faced with a serious flight situation.

Personal operating procedures

Every pilot should develop, and follow, their own set of personal operating procedures and apply them, where applicable, to each flight operation e.g. a procedure to be followed if unsure of position on a cross-country flight, or the turn-back criteria if you find yourself flying toward rising terrain and a lowering cloud base, or having the self-discipline, when under time or other pressures, to decide whether you should take-off in the first place! If there is doubt about the weather the wise pilot leaves the sky to the IFR rated pilot in the IFR rated aircraft. A non-IFR pilot caught out in IMC [instrument meteorological conditions] or dark night conditions will be lucky to survive.

The dedicated pilot flies accurately, using approved technique, knowing the performance (i.e. the best rate) airspeeds for the aircraft being flown and consistently maintaining such airspeeds – and the chosen altitudes and headings. She or he will know the minimum safe speeds for various angles of bank when turning in level, climbing and descending flight – and at varying weights and cg positions. The pilot will know the aircraft's glide performance and, during flight, will be continually monitoring the surface for possible safe landing sites should the engine fail. Such pilots will have developed a set of tolerances for personal performance assessment e.g. airspeed consistently within 5 knots, altitude within 100 feet or heading held within 5°. The dedicated airman or airwoman aims to fly with style, making smooth, timely and balanced transitions when turning, climbing, descending or leveling off so that the flight path flows, rather than being seen as a string of loosely connected manoeuvres. Every landing is a gentle arrival that doesn't strain any part of the aircraft.

ENROUTE ADJUSTMENTS

Module content

- Monitoring and recording flight progress
- Setting compass heading
- Track error adjustments
- Recalculating ETE/ETA and fuel consumption
- Diverting to an alternate airfield
- Line of sight distance and landmarks
- Lost procedure
- Dangers of flight into cloud or when lacking visual references
- Pressing on in deteriorating conditions

Enroute navigation requires the pilot to continually monitor progress against plan; heading adjustments may be needed to maintain the planned route. If progress is slower than planned then diversion to an alternate airfield may be necessary – and there are standard procedures to be implemented when uncertain of position.

Monitoring and recording flight progress

Monitoring involves checking from clock to map to ground – anticipating what should be in view a few minutes ahead – plus intermittent position fixing to establish the track made good, estimate track error and actual ground speed. The essential navigation instruments are just the compass and the clock: to provide direction and ground speed.

Deviations from the track required occur because:

- the pilot is not maintaining the planned heading or has set the wrong heading, for example the heading for another leg
- unrecognised compass error [deviation] causes the heading flown not to be the planned magnetic heading

- the wind velocity is substantially different from that used for the flight plan or it was applied incorrectly during flight planning
- the required track direction was incorrectly measured – or converted to magnetic – during flight plan preparation.

Position fixing

There are basically two methods of fixing the aircraft's position. The first, and the most common in light aircraft navigation, is by identifying a landmark close to the aircraft. The second is by identifying (or establishing) two, or more, lines of position [LOP] such that their point of intersection provides the position fix. A line of position is a line drawn, or already existing, on the chart indicating that the aircraft's position is somewhere along it. Note that there should be a reasonable angular difference, maybe more than 30°, between two LOPs in order to derive a useful position fix.
For flying in Mongolian, with plenty of topographical features (coastline, rivers, road, rail, towns, transmission lines, ridges and peaks), position fixing by landmark identification is quite practical.

Setting compass heading

Most compasses will have differences between the indicated compass heading and actual magnetic heading, due to internal and external magnetic interference. This is the deviation. If the deviation has been measured there may be a compass correction card displayed in the aircraft. Such a card might look like this:

Compass correction card								
Heading magnetic	045°	090°	135°	180°	225°	270°	315°	360°
Compass correction	+2°	+5°	+2°	0	-2°	-5°	-2°	0

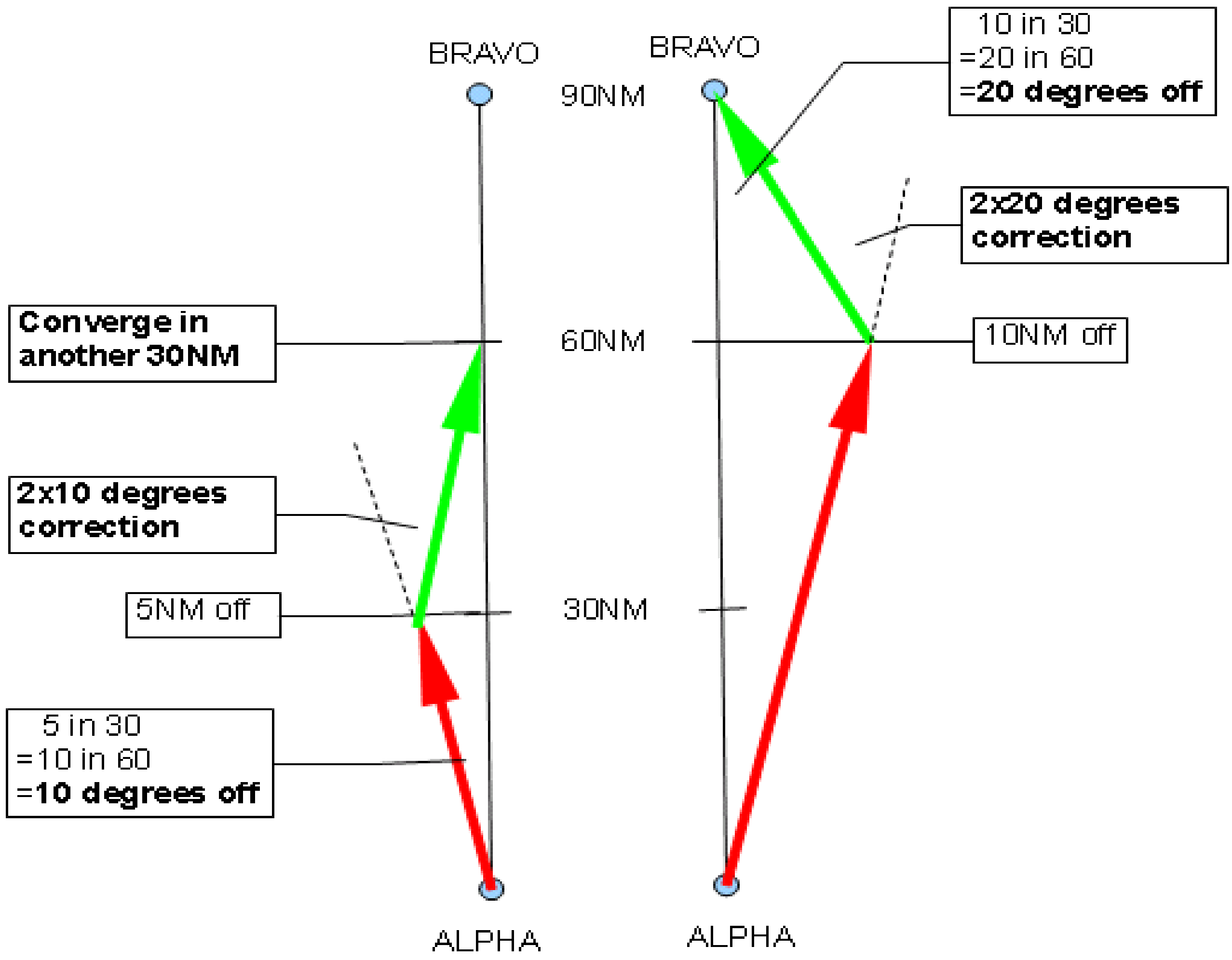
To find the heading to set on the compass just add the deviation value to, or subtract it from the magnetic heading.

Track error adjustments

At any time after departure, when the aircraft's position has been pinpointed and found to be off track, heading adjustments will be necessary: initially to regain the required track and then to maintain it or, alternatively, for a new heading to track directly to the next turning point.
In most cases of pilotage, where track errors are immediately obvious, a simple heading correction will bring you back on track.

Using the 1-in-60 rule

The 1-in-60 rule of thumb can be used to determine track error, given distance travelled and distance off track.
Having pinpointed the aircraft's position, estimate the distance off track (DO) and the distance travelled (DT) along the leg. The **track error = DO/DT × 60**.
If you are less than halfway along the leg, simply **apply double the track error** (in the correct direction) to converge onto track before reaching your destination.
If more than halfway along the leg, track direct to the next waypoint by calculating the closing angle – using the distance off track [DO] and the distance to go [DTG]-**closing angle = DO/DTG × 60**.



Recalculating ETE/ETA and fuel consumption

Being off-track, because of a variation in wind, is much more likely to be noticed quickly than if on track but adversely affected by a stronger than expected headwind, or tailwind. Whenever a position fix is obtained, whether it is on-track or off-track, it is advisable to calculate the ground speed achieved and to re-estimate the ETE for the leg, ETA at the next waypoint and the destination.

Ground speed [GS] in knots is distance travelled [DT] / elapsed time in minutes [ET] × 60
and
Time in minutes to the next waypoint = distance to go [DTG] / GS × 60

Checking fuel consumption

Fuel flow indications may be monitored for abnormalities as part of the continuing in-flight instrument scan, however a calculation of consumption rate should be made at half-hourly or hourly intervals to check for any significant variation from the hourly consumption rate used in the flight plan. **Fuel consumption should always be measured in terms of time not distance.**

Diverting to an alternate airfield

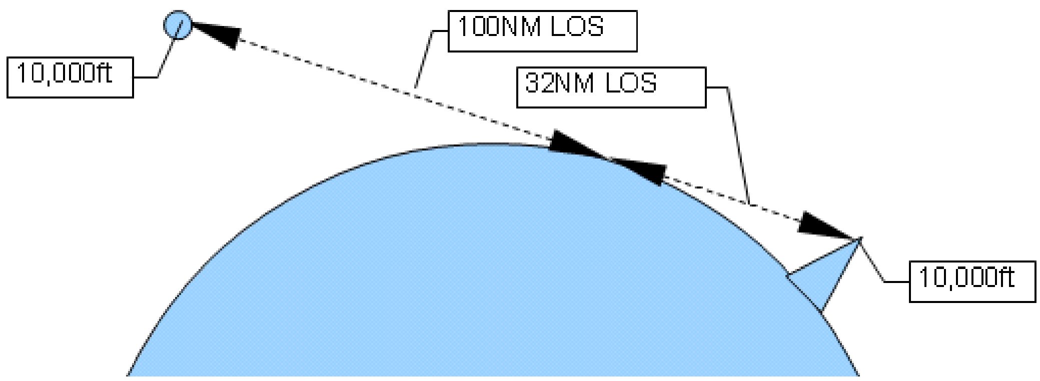
During flight the pilot should always be aware of the general direction of the planned alternate airfields so that, should a diversion be deemed necessary the aircraft can be headed in the general direction of the selected alternate without unnecessary delay. The mental calculations required to refine the heading, estimate distance, ETA and fuel requirement are then done without wasting time and fuel.

Line of sight distance and landmarks

Knowledge and use of landmarks is an essential part of ultralight pilotage, thus on cross-country flights it is useful to know at what distance any landmark, particularly those distinguished by height and shape, might be discernible. The rule-of-thumb is, given unlimited visibility and an eagle eye, **the maximum optical line of sight (LOS) distance in nautical miles is equal to the square root of the observer's height in feet**. VHF transmissions are also LOS.

Theoretical LOS distance to horizon	
Observer height (feet)	**Maximum LOS distance (NM)**
10	3.2
100	10
1000	32
10,000	100

The theoretical distance, in nautical miles, at which a landmark may be seen is near enough to the sum of the square root of the height of the top of the landmark [in feet] and the square root of the observer's height. Theoretically then a pilot flying at 10,000 feet might first see the highest point of an island, with an elevation of 1000 feet, from 132 nm away [100 + 32].



Lost procedure

There are occasions during a cross country flight when the pilot is uncertain about the aircraft's position, particularly when there are considerable distances between verifiable landmarks and a near-track landmark has not come into view. However if proper flight planning and checking procedures are followed and actual vs planned flight progress is continually monitored and recorded then probably the only way to become really lost inclement weather and reasonable visibility is if an enroute heading adjustment is incorrectly calculated or implemented, or if a turning point is overflown without noticing.

There are a few rules which must be followed if thought to be lost or caught in a difficult situation:

- **Fly the aeroplane!** You must not concentrate all attention on the navigation problem, keep the normal scan going otherwise you can readily lose control of the aircraft.
- If the ETA at the next waypoint has not yet, or only recently, lapsed then hold the heading – resist the temptation to start wandering about searching for landmarks.
- However if the ETA at the waypoint has significantly passed then choose a landmark below the aircraft, log the time and then orbit the landmark while you carry out a quick recheck of the running log and previous mental DR and start the procedure detailed in the next paragraph, but don't forget rule 1 **Fly the aeroplane!**. There is no point in wasting fuel while doing this so reduce power, and airspeed, to the best endurance setting for a safe flight speed. If no obvious error is found which will provide the basis for a position estimate then:
- If below 3000 feet AGL then climb a little, cloud base permitting. The theoretical line of sight distance at 4000 feet AGL is 65 NM all round which provides sufficient coverage for the 'Mk1 eyeball' to pick up all the major

landmarks, near and middle distance, which aren't concealed by terrain or atmospheric conditions. If climbing takes you above an inversion layer you may find surface visibility is better just below the inversion. Remember that on a bright day scattered cloud shadows may make some landmarks difficult to pick up even if relatively close. Reduce power back to best endurance.

- **Read from ground to map!** Normally in flight the navigator should be continually identifying features on the map and waiting for the next one to come up on track, within an estimated time. When uncertain of position the procedure is reversed, look for two or more large features on the ground and then identify features on the chart that are in the same juxtaposition. Prominent line features are best although, quite often, a spot feature is easily identified. If you see a prominent line feature, then fly along it until you can derive a fix from an intersect or a verifiable landmark.
- **Don't stay up too late!** Be prepared to make a precautionary landing well before the fuel content reaches the 30 minute reserve figure and well before oncoming twilight reduces visibility at ground level. You need to ensure that a precautionary landing isn't downgraded to a forced landing because of fuel exhaustion. Try to select a suitable site near a house, remember after you have landed you still have to secure the aircraft, protect it from stock and perhaps get some help – very difficult in the bush and in the dark!

There are many circumstances where a precautionary landing is a wise move, among them:

- Deteriorating weather
- Oncoming darkness
- Fuel reaching reserve level
- Lost and you decide to obtain help on the ground
- Engine rough running [although this might be considered a forced landing]
- Occupant illness

The technique for precautionary landings at other than a prepared landing ground is essentially the same as that for short field landings except that additional low level passes should be made to check the hazards with particular care in wire location and avoidance. Map out the landing/run-out path and also determine the escape route in the event of an aborted landing.

And lastly –

- **Communicate!** Share the problem.

Dangers of flight into cloud or when lacking visual references

The human vestibular system

When walking, a person's prime sense of orientation is provided by visual references but if vision is severely degraded the vestibular system in the inner ears, which senses motion and gravity (thus roll, pitch and yaw), generally allows us to keep our balance. However the vestibular system is not designed for high speed or angular motion and cannot be used as an inflight back-up system, i.e. you cannot close your eyes and continue to fly straight and level. Motion of the fluid within the ears' semicircular canals is affected by inertia and will feed quite erroneous prompts to the brain resulting in various types and levels of vertigo.

For example – without the external visual references of clear sky, terrain or a horizon – forward deceleration tends to impart a pitching down sensation whilst forward acceleration gives a pitching up sensation. Once settled into a constant rate turn the sensation is of not turning at all, but when the turn is halted the sensation is then of turning in the opposite direction. In addition the vestibular system will not detect slow rates of bank so that if the aircraft is banking at the rate of one or two degrees per second the vestibular system won't send any prompts to the brain, which will consider the aircraft is still flying straight and level, while any associated speed changes may provide contrary sensations. For example if the aircraft is slowly banking and accelerating in a descending turn the sensation may well be one of pitching up. Such sensations disorient the pilot.

Spatial disorientation

Aircraft accidents caused by spatial disorientation are usually fatal and occur when VFR flight is continued in adverse visibility conditions — cloud, fog, smoke, haze, showers, darkness and combinations thereof. Pilots who have not been trained to fly solely by visual reference to the indicators in a specialised "blind flying" panel/display will soon find themselves experiencing spatial disorientation should they, inadvertently or deliberately, enter instrument meteorological conditions [IMC] where the external visual references – by which they normally orient themselves in visual meteorological conditions – are lost. The same applies to any atmospheric condition where the visual references – horizon [principally], terrain and clear sky – are lost or just significantly reduced, see white-out/flat light for example.

Thus a non-instrument rated pilot would be unable to maintain controlled flight in cloud, or maybe even in conditions where the horizon disappears, and even an instrument rated pilot cannot fly in cloud without the minimum IFR instrumentation. Nor can an instrument rated pilot in an IFR aircraft fly where the aircraft can't out climb rising terrain, whether it is concealed or not; in addition many horrific accidents have occurred when an IFR pilot has descended below the area 'lowest safe altitude' in IMC and impacted the terrain; such events are classified as controlled flight into terrain.

Note: even a pilot who is well experienced in flying in instrument meteorological conditions may occasionally experience a phenomenon called "the leans". This might occur when the IFR equipped aircraft has been inadvertently allowed to slowly bank a few degrees and the pilot then makes a quick correction to level the wings. The vestibular system doesn't register the initial bank but does register the wing levelling as an opposite direction bank (away from a wings level attitude) and the pilot's brain produces a leaning sensation while also perceiving from the instrument readings that the aircraft is flying straight and level. The reaction – which can persist for quite a while – may be for the pilot to lean sideways in her/his seat so that everything feels right!

Pressing on in deteriorating conditions

Most fatal excursions into IMC by ultralight aircraft seem to occur when the pilot freely elects to find a path through or over high terrain beneath an overlaying cloud cover in order to maintain a time schedule but without ensuring that there is a clear way out or back.

Apart from accepting that you will not be able to cope with adverse weather conditions encountered at low levels and thus positively resisting that urge to press on or get home [which urge seems to become quite strong once you have passed the half-way point] the following rules can save your life.

- **Stay in the clear!**
  - Watch what is developing around you — including behind you.
  - Don't fly towards worsening weather, if you have to change course fly towards better conditions/terrain.
  - In conditions where the METARs indicate little spread between temperature and dewpoint – or the air just feels cooler and damp, perhaps a bit drizzly – watch out for mist, fog, fractus or scud suddenly forming, particularly in valleys, across ridge-line saddles or on wooded slopes and more so in the late afternoon which, when combined with a compunction to get there before dark, can lead to disaster. Also the gaps in a layer of broken cloud, in front, behind, above or below you, may start to close-in at any time and very rapidly.
  - When any doubt exists make a 180° turn or divert towards better conditions; the accident reports cite too many instances of light aircraft 'controlled flight into terrain' or 'continued VFR flight in adverse weather' because of increasing cloud cover, a lowering cloud base or reducing visibility probably because the pilot thought 'I'll just go a bit further and see what the conditions look like there'.
- **Be wary of lowering cloud and rising ground!**
  - If you can't see a gap between the horizon and the overlaying cloud base be absolutely sure you can proceed and be very careful that (a) you are not gradually climbing and losing airspeed and (b) that you don't get into a position where poor visibility precludes making a 180° turn without entering cloud.
- **Be wary of valleys!**
  - If you can't see the tops of surrounding hills because of cloud don't fly into a valley unless (a) you can clearly see the exit and the horizon is quite clear and well defined at that end and (b) the valley is clearly wide enough to do a 'U' turn at any time.
  - In addition possible turbulent down flows over the windward slopes warrant some precautions when turning.
- **Be wary of concealed CB and squall lines!**
  - When flying below low and mid-level unbroken or broken cloud layers cumulonimbus and squall line development may be concealed from view and you may suddenly encounter extreme turbulence, wind shear and very heavy rain with consequent loss of VMC in the worst possible conditions.
- **Don't get caught on top!**
  - If caught above what appears to be an extensive cloud layer it is generally wise to turn 180° and climb for a better line-of-sight distance while returning to clearer sky but remember the wind velocity changes with height so what may be a favourable wind at low level may be unfavourable at height.
- **Be wary of sucker holes!**
  - If caught out above a cloud layer be extremely wary of descending through a hole in the layer.

- Such holes tend to suck you in but, if the hole starts to fill or proves not to be wide enough to conduct a safe slow speed descending turn, disorientation may spit you out the bottom.
- Also you have to be sure that, having descended through the hole, the height of the cloud base, terrain and visibility will allow safe onward passage in VMC under the cloud cover, or at least the option of a safe precautionary landing.
- Once descending in a sucker hole it may well prove impossible to climb out of it — without entering cloud — if you change your mind.

THE GLOBAL POSITIONING SYSTEM

Module content

- Global Navigation Satellite Systems
- GPS receivers
- GPS applications
- GPS constraints

GPS technology provides precise position fixing capability and excellent Dead Reckoning capability, when combined with a stored flight plan. Improvements in the integrity and availability of GPS, and increases in signal strength, are making ground based radio navigation systems redundant. GPS navigation will eventually be accepted as a sole means of enroute navigation – *provided the aircraft is fitted with an approved GPS system and the pilot appropriately trained.*

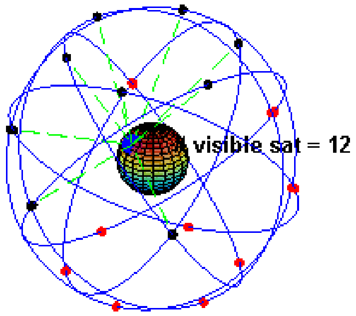
Global Navigation Satellite Systems [GNSS]

GNSS is the generic term covering satellite based area navigation systems. The first such — and currently predominant — system is the Global Positioning System [GPS] initially developed by the United States Department of Defense for position fix coordination of the inertial navigation systems [INS] on board military aircraft and cruise missiles. GPS has since become freely available as a valuable supplementary navigation aid to civilian aircraft of all types and all nations – with the compliments of U.S. DoD. The Russians implemented their GLONASS GNSS system some time ago and the European Union is now establishing Galileo, a companion GNSS system to GPS.

GPS

GPS or the NAVigation Satellite Timing And Ranging [NAVSTAR] system consists of a minimum 24 (typically 32) satellites (of which usually three are operating spares) orbiting Earth at an altitude of 20 000 km with each unit taking about 12 hours to complete one orbit. The NAVSTAR orbits are arranged in six planes with 3 to 4 satellites in each plane. This configuration ensures that a minimum of four satellites would be in view from most locations on Earth at any time. Each NAVSTAR unit is solar powered and equipped with atomic clocks for extremely accurate time measurement. The satellites have an operational life of around 10 years so there is a continuing replacement program, which also allows phased introduction of new technology and expanded facilities. Early launch of replacements often provides more than 24 units in orbit.

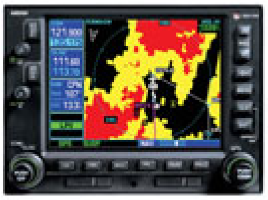
NAVSTARs continuously transmit information on very low power at two UHF L band frequencies, a coarse acquisition ranging code [the C/A code] on 1575.42 MHz and an encrypted precise positioning service code [the P code] on 1227.6 MHz. The C/A code is freely available to all while the additional P code is only available to authorised users. The C/A code is designed to provide a latitude/longitude position fixing accuracy within 20 metres 95% of the time; but probably better than 20 metre accuracy is achievable most of the time. Similar accuracy is achieved in reporting an aircraft's elevation above a particular reference level. At present it is far more accurate than NDB/ADF or VOR and certainly more accurate than necessary for VFR flight.



In aviation a 'sole means' precision IFR navigation system has to meet certain standards with respect to accuracy, integrity, availability and continuity of service. GPS by itself cannot meet those standards, however the ICAO nations are developing a sole means global navigation satellite system based on GPS and Galileo [Galileo is due to be operational in 2008] but augmented with ground and space based correction [or differential] systems, airborne avionics and digital data link communications and control between aircraft and ground stations. GNSS will eventually make obsolete all VORs, NDBs and other ground based systems* and – as manufacturers are developing low cost light aircraft avionics – it now has considerable spin-off benefits to recreational fliers.

GPS receivers

Manufacture of GPS receivers for all applications is a multi billion dollar industry supplying a wide range from comparatively inexpensive handhelds, such as the Garmin E-Trex, to very expensive panel mounts with integrity monitoring, ground based position correction capability, colour moving map position displays, and an airspace and airfield database.



In essence the aviation GPS receivers use the information contained in the C/A code, emanating from each satellite in view, to measure the time lapse of a received radio signal, calculate the distance to each satellite's position and then establish the receiver's three dimensional position by trilateration – a form of triangulation – of the distances from a minimum of three satellites.
For more detail download the Garmin GPS Guide for Beginners It's in PDF format and about 524k. Trimble also have a good GPS Tutorial
The distance calculation is derived from the time taken for a satellite radio signal to reach the receiver. As electromagnetic waves, in space, propagate at a speed close to 300 000 km/sec the time taken for the signal to reach the surface from a satellite overhead is 20 000 / 300 000 seconds – about 0.067 seconds. It is also evident that if a position accuracy of, say, one metre is desired then the clock in the GPS receiver must be able to measure transmission times in nanoseconds [billionths of one second].

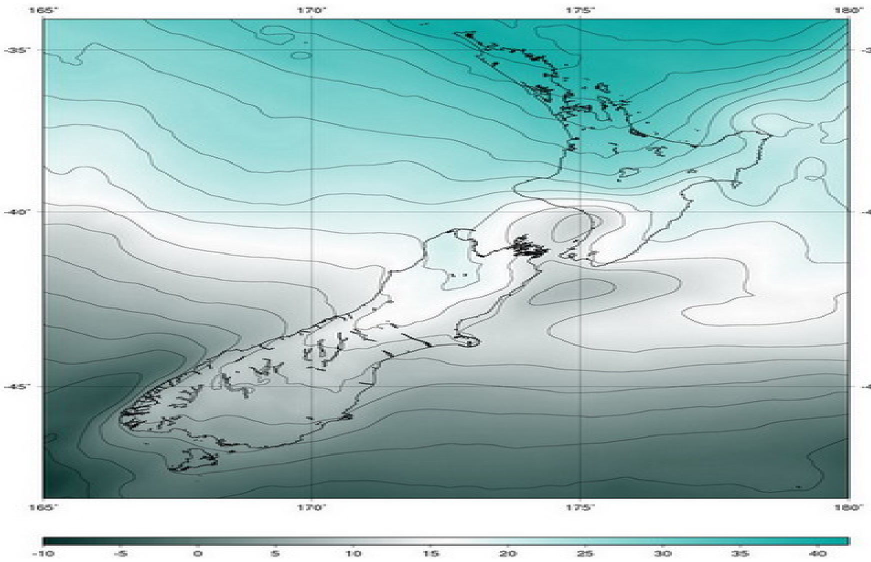
Handheld GPS receiver databases

Aircraft positions are calculated by the receiver in terms of latitude, longitude and elevation. The receiver chips contain mathematical models of the Earth, the most accurate, and commonly used for aviation purposes, is the World Geodesic System 1984 [WGS84] which is the datum for VNCs, VTCs, aerodrome reference points, VOR sites.
Handheld receivers may contain a user's database to store a number (maybe 250 or 500) of user defined **waypoints** (name, latitude and longitude) and maybe 20 flight plan **routes** each typically allowing a maximum of 30 waypoints. Aviation handhelds will also provide a recognised standard **aviation navigation database** (compiled by commercial organisations such as Jeppesen, Pocket FMS, etc), containing location/elevation co-ordinates and other information for all aerodromes plus VORs, NDBs and intersections shown on Enroute Charts plus controlled and special use airspace . Those location references may also be used as waypoints when defining routes.

The receivers provide quite sophisticated "moving map" monochromatic or colour LCD graphics which display the aircraft's position and the relative position of all the waypoints and aviation related detail within a user defined range. The diagram or map can be configured to remove unnecessary items from the display and thus present a less cluttered image.

Calculating height

Altitude is calculated as the height above the WGS84 ellipsoid, which differs from the geoid. In Mongolian the geoid-ellipsoid separation varies between zero and 40 metres. Newer GPS receivers include tables (based on latitude/longitude grids of varying block sizes) of the geoid-ellipsoid separation values which allow the altitude above the geoid to be displayed, if that option has been selected.



Configuring displays

Aviation GPS receivers offer a variety of screen displays with content user configurable and varying between models. The most useful displays for navigation purposes are two; a moving map screen and an alphanumeric navigation page that includes a CDI.

Some handhelds also provide a very basic ground map which is usually just a monochromatic grey scale representation of a few significant line features (highways, railroads, coastlines) on which the aviation related detail is overlaid. This is generally sufficient for VFR non-primary navigation use but there are some expensive units on the market which provide a topographic, colour moving map display. Some of these are not current VNCs or VTCs and such map displays may have some detail deficiencies, but many manufacturers provide an upgrade service to maintain current VNCs and airspace databases.

The basic moving map, which is the preferred navigation mode, is usually configured to show an aeroplane image at the lower centre of the screen representing the aircraft's position in relation to the flight planned track between current waypoints, airfields and controlled airspace etc. The display can be configured as 'north up' or 'track up'; most people seem to prefer the latter. The track made good will also be displayed together with bearing and distance to the next waypoint. The display can normally be zoomed in or out and thus represent an area ranging from a few square miles to thousands of square miles.

The alphanumeric display might show track made good, groundspeed, distance and bearing to the next waypoint, ETE to the next waypoint plus a course deviation indication similar to that of a VOR Omni Bearing Indicator. The division dots on a GPS CDI are not spaced at two degree intervals, but indicate distance off track with the interval between dots being user scalable from maybe 0.25 nm up to 5 nm. Some devices may change scale automatically as the waypoint is neared. The bar indicates where the required track is in relation to the aircraft e.g. if the interval is set at one nm and the bar is located 3 divisions to the right of centre then the required track is 3 nm to the right.

GPS applications

The prime GPS use is in enroute navigation, monitoring flight progress against the established flight plan and making the heading corrections necessary to maintain the required track. This requires entering the planned route to the GPS database, activating that GPS route on take-off and making the necessary adjustments, as indicated by the GPS, to maintain track.

When used in the moving map navigation mode the GPS display exactly complements the enroute navigation techniques expounded in this section of the Training Manual.

Once airborne,and the receiver has locked on to the necessary number of satellites, the planned route is pilot activated. The receiver recalculates the aircraft's position at set intervals of one or two seconds, or less, keeps a history log of the track made good and continually recalculates groundspeed and distance off track.

The GPS receiver homes to the next waypoint by indicating the bearing. However if you just fly that bearing, without any heading adjustment for the crosswind component, the bearing will keep changing due to the drift and you will eventually arrive at the waypoint but the track followed will be curved and the magnetic heading flown will be consistently changing. Thus to maintain a constant heading, and the direct track, you still have to calculate, and apply, the wind correction angle.

The GPS doesn't directly calculate the heading to fly either to regain the planned track or to fly direct to Warraway. However you don't need to estimate the track error from your chart, the GPS shows the track made good as 077°, the track required was 083° thus the track error is 6°. You can then apply the double track error technique to regain and hold the original track. You will know you have regained track when the GPS indicates that the bearing to the waypoint is 083° so you then make the necessary heading adjustment to maintain track.

If you continue to adjust your heading so that track made good, not your heading, matches the bearing you will theoretically continue tracking directly to the waypoint.

Alternatively if you prefer to fly directly to the waypoint, rather than first regaining the original track, a quick mental calculation of track error/closing angle will provide the WCA to accomplish that.

e.g. Track required: 083° Track made good: 077° thus opening angle = 6°. Track required: 083° Bearing to waypoint: 085° thus closing angle = 2° Opening + closing angles = 8° WCA to track direct to the waypoint. In fact that calculation is simplified by using the difference between the track made good and the bearing – i.e. bearing 085° track made good: 077° thus WCA = 8°.

Some handhelds may do the calculation for you in providing a TURN display, which is just that difference between the track made good and the bearing.

Some handheld aviation GPS receivers provide an E6-B page where, if you enter the heading being flown and the true airspeed, the receiver will estimate the 'winds aloft' from the TMG and groundspeed and then calculate the heading to fly. However due to the limited key board it is not so easy to input data during flight in a light aircraft – impossible if you are wearing gloves – so it is much easier to just use the variant of the track error/closing angle calculation outlined above.

Remember that during flight under the Visual Flight Rules you are required to navigate by visual reference to the ground, not the GPS display. That display should only be a fractional portion of your continuing scanning pattern.

Emergency search feature

Most GPS receivers all provide an emergency search key possibly labelled 'GOTO/NRST'. Pressing this key once will bring up a screen displaying the 10 nearest airfields extracted from the database together with the distance and bearing to each. Highlighting one of these airfields and then pressing the 'GOTO/NRST' key again will bring up the alphanumeric navigation screen to 'go to' that airfield. However, and this is a big however, the GPS indicates the direct route to the selected airfield not the safe route. The GPS does not take into account the type of terrain or the height of terrain – the GPS indicated route might be over 'tiger country' or straight through a mountain.

The 'GO TO' function is for emergency use, you must not use it as a substitute for proper route planning.

GPS constraints

Antenna placement. The capability of a handheld receiver is greatly reduced if the receiver antenna is sited where it is shadowed by the airframe or is within one metre of a VHF antenna. An externally mounted antenna usually provides the best reception.

Interference. The GPS signal is very weak, and actually quite easily corrupted by interference. Ensure that the mounting/placement of the GPS unit, and associated cables, within the cockpit can cause no interference with the magnetic compass; and other equipment within the cockpit (including cell phones) can't interfere with the GPS receiver.

Integrity. Approved panel mounted GPS receivers have an inbuilt integrity monitoring and warning system called RAIM – Receiver Autonomous Integrity Monitoring. Handhelds only have the ability to inform the user when navigation has ceased entirely, they don't warn when a significant degradation in accuracy is occurring.

Satellite signal quality- The SQ number is an indication of signal to noise ratio for each satellite in view; 0–1 is useless, 2–3 is undesirable and 7–9 is good. The SQ may be indicated as an un-numbered bar chart but the scale usually reflects the 0–9 range.

Horizontal dilution of precision [HDOP]. Some handhelds may show the HDOP value reflecting the relative geometric positioning of the satellites in view. Low HDOP [less than 02] is best, high HDOP [greater than 06] is not so good for accuracy.

Ease of use. The keypads of aviation handhelds are not designed for entering data whilst flying a light aircraft, thus it is very difficult to change route details, for instance, whilst airborne. Some GPS receivers now on the market, purporting to be aviation receivers, seem to have been designed for the much larger road vehicle market.

Improper use of the 'go to' function. There is always the temptation to use the 'go to' function as a replacement for proper flight planning.

ELECTRONIC FLIGHT PLANNING AND NAVIGATION

Module content

- Navigation information databases
- Digitised aeronautical charts
- Flight planning software

GPS technology combined with an accurate aeronautical database provides excellent position fixing capability — and excellent DR capability when associated with a stored flight plan. GPS is not yet classified as a sole-means navigation system under the VFR and is only officially regarded as a primary-means day VFR navigation if the GPS system accords with the FAA's Technical Standard Order [TSO] C129 or TSO C145/6 series or has other approval. However the reality is that many recreational pilots do use non-TSO'd GPS, plus electronic on-screen position tracking (i.e. a moving map display), as the primary means of airborne navigation.

When a small portable computer is used for a true topographical moving map display then additional material can be added to create 'personal' charts; plus weather, NOTAM and so on can be stored. Thus the concept of the 'electronic flight bag' is introduced – hopefully with paper charts and manual pilotage as the backup system.

So electronic flight planning and electronic navigation is becoming the norm for many recreational pilots, not least because the availability of powerful, inexpensive – but highly reliable – desktop computers, handheld PDAs and handheld GPSs (or GPS cards) is now associated with a proliferation of quality utility software – readily and cheaply available to all via the internet – allowing any reasonably computer adept person to put together a system of software, general purpose (rather than application oriented) hardware and navigation databases tailored to their particular aviation needs; all without excessive cost.

Good electronic VFR flight planning should only differ from the manual flight planning described in prior modules, in that digitised – rather than paper –topographical charts are used to plan, and finally plot, the route; and the final flight plan is stored in digital rather than paper and pencil format.

When airborne there is only a slight difference in pilotage where the navigator – while still reading from map to ground – is primarily relying on a cursor on a digitised moving topographical chart to display a constantly updated current position and then confirming it with the ground. The significant difference in airborne navigation is in using electronic DR to provide all the inflight data and corrections necessary to arrive at the planned destination safely: which indicates the vital importance of working with a complete and absolutely accurate aeronautical database.

In addition (as a flow-on from the glass primary flight displays and multi function displays of larger contemporary IFR aircraft) the availability of rather inexpensive non-certified electronic flight instrument systems [EFIS] is increasing. Such non-certified systems can be legally installed microlight aircraft – although there may be a regulatory problem if a non-certified EFIS is providing altitude encoding to a transponder. These flight instrument systems are software based and, in future, are likely to provide increasing data transfer to/from other avionics within electronic communications, navigation and surveillance technology.

It is possible that ADS-B will be operational in the lower levels of Australian airspace within a few years. It is then likely that a handheld PDA, linked to the ADS-B device, could be used for a low cost cockpit display of traffic information overlaying a moving topographic map.

Electronic planning and navigation should follow the same procedures described in the preceding modules:

- Accessing airfield and airspace information
- Plotting a route on an aeronautical or topographical chart
- Accessing TAFs, ARFORs and NOTAM
- Doing the E6b calculations and producing a flight plan
- Monitoring flight by checking from map to ground and
- Making the necessary enroute flight path adjustments.

Navigation information databases

In manual flight planning navigation information is obtained from printed documents – VNCs and other reference charts – containing details concerning aerodromes, navigation aids, air route intersections, special use airspace, airspace boundaries, magnetic variation and communications frequencies: obviously location latitude, longitude and elevation are particularly important details. The digital version of such print information is the aeronautical navigation database. Such databases are supplied via various media, including plug-in data cards and internet download, and it is most important that the compiler/distributor of the database material has a quality assurance system that guarantees the accuracy of the data. Jeppesen is regarded as the best source – certainly the best known – but most flight planning software includes a proprietary database and, hopefully, some guarantee of its quality level. In some databases the aerodrome runway data also includes a graphic display.

In addition to the database a full function GPS receiver will utilise a built-in ground map or 'base map' and the data that can be displayed graphically, such as locations and airspace boundaries, is extracted from the database and represented by icons on the basic map page. The base map in a GPS receiver usually cannot be updated or changed over although some receivers employ a programmable plug-in cartridge and other maps can then be loaded.

The problem for recreational pilots is that the standard aviation databases – the Jeppesen for example – are amended monthly, thus an initial database will become increasingly out of date. However the bulk of the database changes relate to refinements that are probably only applicable to IFR operations. The updates come in CD form for use in PCs connected to the GPS receiver via a special data cable, or in a replaceable data cartridge format. Update subscription services are comparatively costly for the non-professional so the fine judgement for recreational pilots is when, or how often, to update the database. However as non-TSO'd GPS is officially only a supplemental-means navigation tool and, if VFR pilots in Australia always check – pre-flight – the airfield information contained in AIP on-line, then the only significant area for doubt is in changes to controlled airspace or special use airspace boundaries. The use of current VNC and VTC charts [paper or digitised] and reference to NOTAM during flight planning will preclude any problems in that area.

The data for airfields that are not contained in a standard aviation database can be entered in a user's database if required, but the need for absolute assurance that location coordinates and elevations have been correctly ascertained and entered, cannot be over-emphasised.

Digitised aeronautical charts

Route construction in electronic flight planning follows the steps outlined in previous sections using trip planning software on a desktop computer. Much of this specialised software now utilises digitised aeronautical and topographical charts.

The **raster** format is for use in desktop computers with flight planning software and for inflight use in laptops or PDAs with moving map software. GPS moving maps use **vector** digitisation and are usually only available from GPS manufacturers or their distributors.

A vector image is a series of mathematically defined points, lines and polygons (closed shapes) whereas a raster image (such as that from a digital camera or a scanner) is a matrix of rows and columns each cell containing a picture element [pixel] with a discrete colour value – a bit-mapped image – a BMP, TIFF, JPEG, GIF or PNG file. Vector based images allow 'zoom-in' without distortion, whereas rasters do not; unless a larger file has been created containing several 'zoom' levels. When a paper map is scanned to produce a raster image a few latitude/longitude control points have to be identified and stored in a calibration text file together with other essential information such as the map projection and datum; this may require some utility software which is generally included in flight planning software packages or possibly just a normal text editing utility. There is software available to convert raster to vector, and vice versa.

As every pixel in a bit-mapped image can be edited (the colour value changed with image manipulation software) then permanent user data and symbols – for example, the verified position and name of a private airstrip or a named waypoint – can easily be added to the original image (with careful matching of font, size and colour) to create a personalised chart [WAC or VNC for example].

Flight planning software

A range of desktop computer flight planning software is available to facilitate route selection. Waypoints are selected (either from a table or by point-and-click methods) and the planned route(s) plotted on a chart display.

Some software requires basic performance, fuel consumption and other data for the user's aircraft to be pre-stored then, after entering forecast wind velocity for various altitudes, E6B software calculates much the same information as acquired/calculated manually in section 5.4, thus allowing the user to select an optimum route and cruise altitude.

The route, resultant flight plan and other data can then be printed or uploaded into a GPS, laptop, smartphone or EFIS. Most flight planning software supports import/export of waypoint files.

9. Navigation

The earth has a weak magnetic field, which culminates in two internal Magnetic Poles. These are situated near the North and South Geographic Poles (Geographic poles being on the earth's rotational axis).
The magnetic compass is a simple instrument which operates on the principal that a freely suspended magnetic needle will align itself with the earth's magnetic field, providing a datum for measuring direction on the earth's surface.

The Compass Rose

If a circle is divided into 360 equal parts and numbered clockwise from 0 to 360, then this will divide the circle into 360 degrees. Each division is one degree. Degrees are always expressed as a threefigure group, for example:

45	becomes	045
7	becomes	007
325	remains	325

Magnetic and True North

Although the earth's magnetic field lies roughly north and south, the earth's magnetic poles do not coincide with its geographic poles. Therefore, at most places on the earth's surface the compass needle will not point to true north pole, but to magnetic north pole.

Variation

The difference between magnetic north and true north (as represented by lines of longitude on charts) is expressed as an angle called Variation.

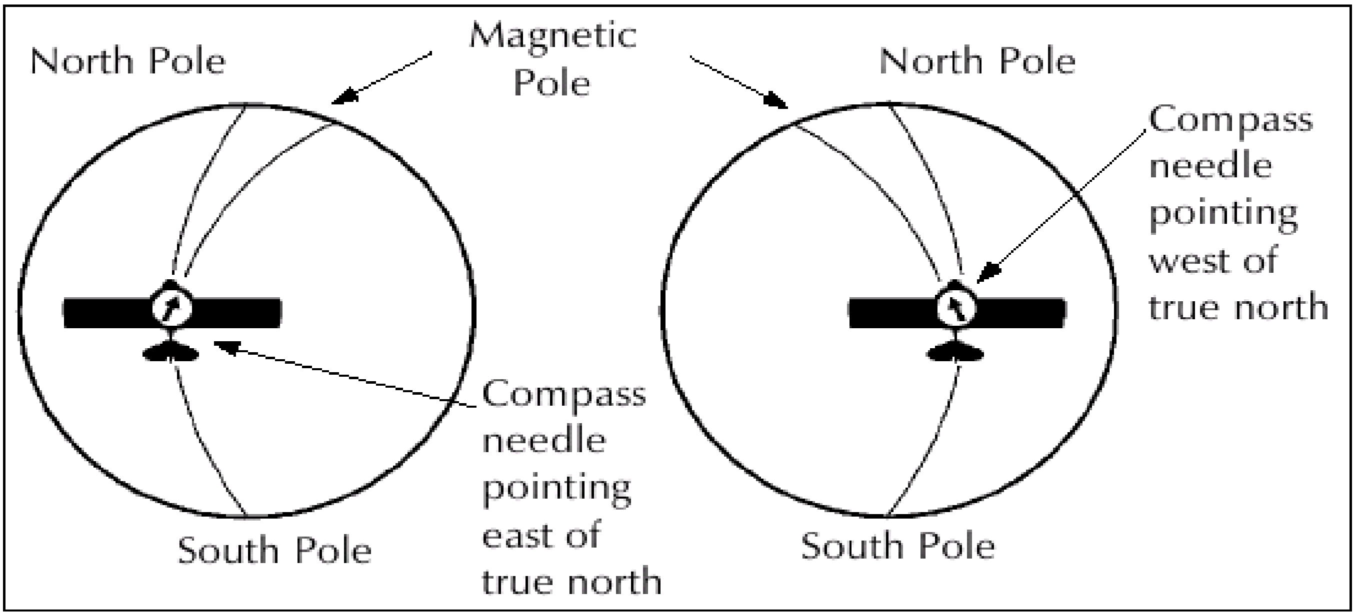


Fig. 107 Variation is called westerly if the compass needle lies to the west of true north, and easterly if the needle lies to the east of true north.

If variation is westerly, add it to True to get Magnetic. If variation is easterly, Subtract from True to get Magnetic.
Remember this: Variation East, Magnetic Least Variation West, Magnetic Best.
Variation is different for different places on the earth's surface. Furthermore, local magnetic fields from mineral deposits and other conditions can distort the magnetic field causing additional errors.
Variation is shown as broken lines joining points of equal variation on your charts; these lines are called Isogonals.

Deviation

Actually, the magnetic compass is rarely influenced solely by the earth's magnetic field. Metals, electrical equipment and even your microlight's airframe can influence the compass causing additional error.
The difference between direction indicated by an undisturbed magnetic compass and that indicated by a magnetic compass in an aircraft is cal ed deviation. To eliminate this error a process known as "swinging the compass" determines the error for any heading and is shown on a card next to the compass. This tells the heading to steer to compensate for deviation.

Magnetic Headings	**Steer by Compass**
North	001
North East	045
East	091
South East	136
South	180
South West	223
West	266
North West	314

Fig. 108 A typical compass card.
Remember: any metal object placed near the compass may cause considerable error.

Longitude and Latitude

For the sake of convenient reference, the spherical surface of the earth is crossed with two sets of imaginary lines, called:

- Meridians of Longitude
- Parallels of Latitude

Every point on earth has a line of Longitude and Latitude running through it.

Longitude

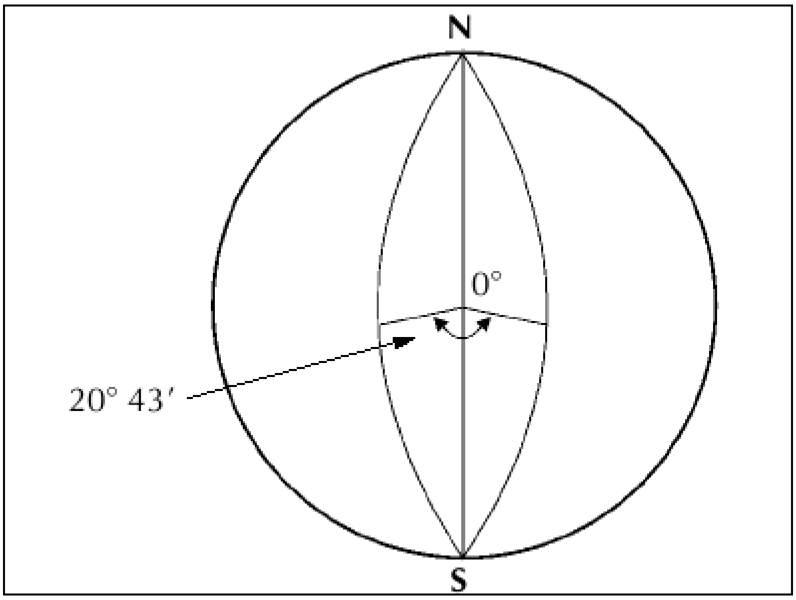


Fig. 109 Lines of longitude join the North and South Poles.

These lines are referenced through a line passing through Greenwich, London (0 360). At 180 from the Greenwich reference line the earth is halved and we have degrees longitude east and west. Thus 181 east becomes 179 west. The figure below shows this as it would be observed from above the north pole.

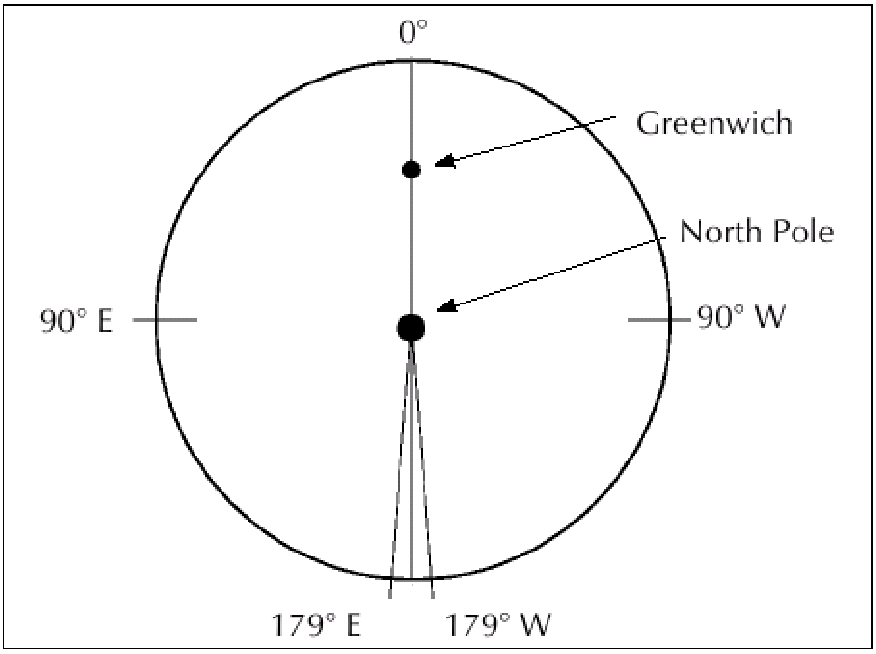


Fig. 110 Observing from above the North Pole.

The lines referenced throughout 0 (Greenwich) are usually expressed in degrees and minutes (a minute is 1/60th of a degree) and written as, say, 20° 43' west, often abbreviated to 2043 W. The distance between lines of longitude one degree apart varies from 60 nautical miles at the equator to zero at the poles.

Latitude

Lines of latitude (or parallels as they are called) are lines which circle the earth parallel to the equator (which is equidistant to the poles). Thus all lines of latitude are parallel. The equator is the reference for latitude, being known as zero latitude.
Degrees of latitude in the northern hemisphere are expressed as degrees north and degrees of latitude in the southern hemisphere as degrees south.

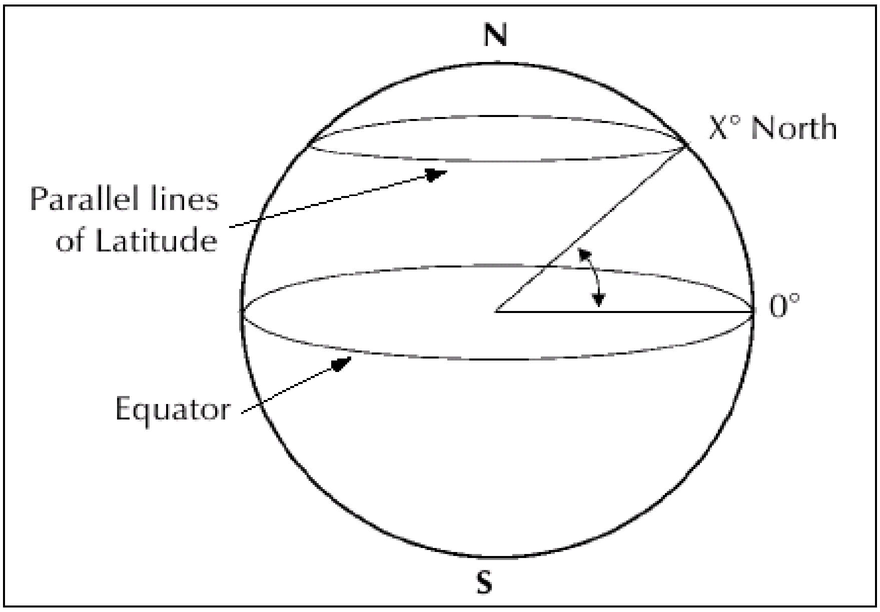


Fig. 111 It is now possible to specify any point on the earth's surface by using a line of latitude intersecting a line of longitude.

Your aeronautical chart has the lines of latitude and longitude printed on it marked in the appropriate degree. Thus for example we can find the point:

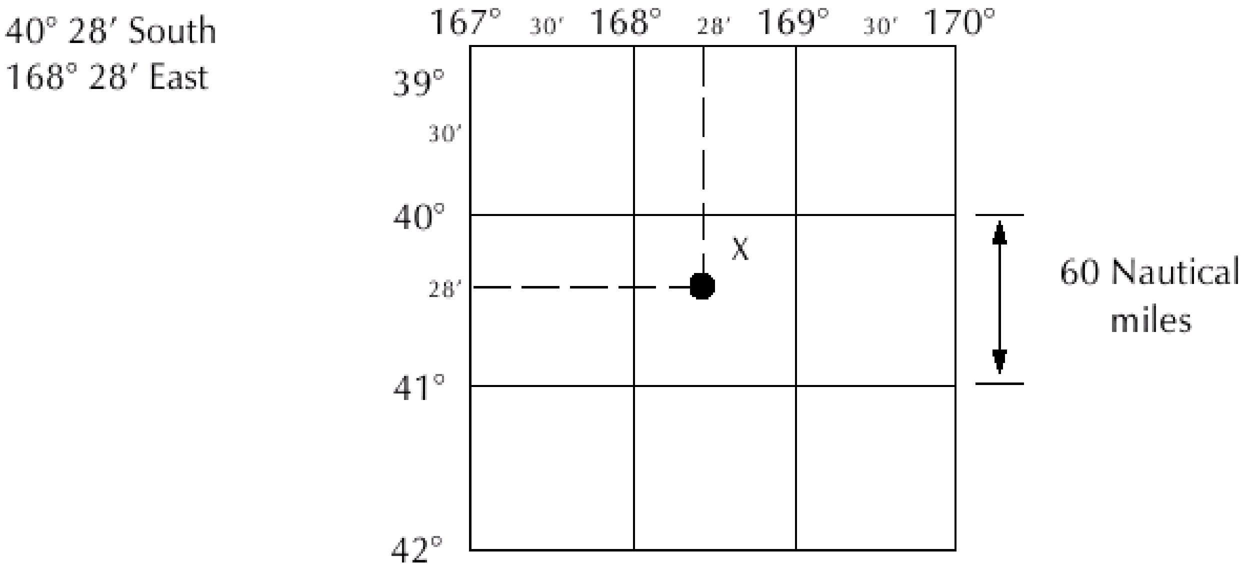


Fig. 112 When indicating a position of latitude and longitude, it is usual to give latitude first followed by longitude.

Of special note: one degree of latitude equals 60 nautical miles one minute of latitude equals 1 nautical mile on the earth's surface. Therefore, the graduations on the lines of latitude on your map may be used as a scale for measuring distance.

AERONAUTICAL CHARTS

An Aeronautical Chart differs from any road map you may use in your car in that it not only is a Topographical (showing heights and contours of the landscape) but is also overprinted with a wealth of information important to you as a pilot.
Obtain the chart covering the area you intend to fly in, from any flying establishment. It is a:

- Topographical Map, or
- 1:500,000 scale (one unit on the map equals 500,000 on the earth's surface), or
- Aeronautical Chart.

On al cross country flights, an appropriate aeronautical chart must be carried. Check the date on the map and be sure to buy the most recently published one available as they are constantly updated.

Relief

Aside from the surface details such as roads, railways, rivers, towns etc. shown on the map, an important feature on these maps is their depiction of the type of terrain. By means of spot heights (above sea level), hill shading and layer tints, a clear impression of the landscape is possible at a glance. There are also contour lines (joining points of equal height), but these are rather faint.
It is these features which allow the pilot to visualise the land as depicted on the map whilst planning a flight or when airborne map reading.

Airspace

Aeronautical maps show controlled airspace very clearly. It is vital that you know whether or not you are flying in controlled airspace of any kind, and road maps do NOT give this information of course!

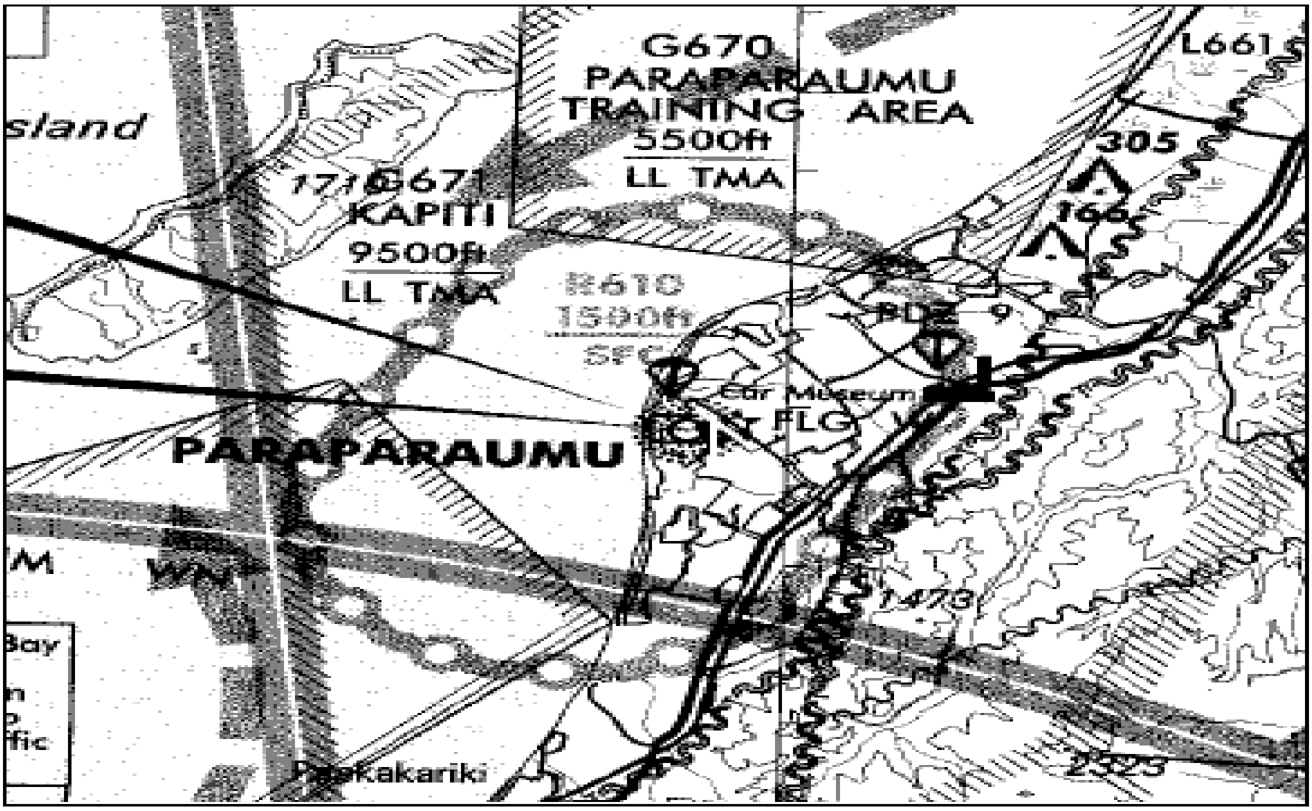


Fig. 112a Attach;tmfig112b.png Fig. 112b

This is reason alone not to navigate with other maps.

Study your Aeronautical map very closely and become thoroughly familiar with the extent of Controlled Airspace in the area you will be flying in.

Accidental or unapproved flight into Controlled Airspace endangers yourself and others, not to mention the setting into motion of some very spectacular Airways Corporation wheels indeed! Keep clear of Danger and Restricted Areas unless you have asked an ATC unit (Air Traffic Control Tower) about operating there.

PLANNING A CROSS COUNTRY FLIGHT

While it is acknowledged that few microlights are equipped with an aircraft type compass, there is a section following showing the proper use of the magnetic compass as an important aid to microlight navigation, however the recommended navigation method is detailed in "Map Reading" on page 106.

Even pilots of microlights without aircraft type compasses should understand the method as it has an application to any cross country flight in as much as the calculation of flight times, the drift to be expected etc is concerned.

The Route

Mark the takeoff and landing points on your map. Now study the map and visualise the route. What is there along the way which may influence the flight?

The direct route may be fine, or perhaps you may need to fly around some high ground or skirt around a populous area for example. Does the route you have chosen offer safe emergency landing areas? These are some of the things to consider.

Choose the proposed route and note the prominent features which will aid map reading.

Distance

On your Aeronautical map the lines of latitude are graduated in nautical miles (these graduations are minutes of latitude). Measure the distance from takeoff along the route to your destination and note it in nautical miles.

Weather and Wind

With the help of the Meteorological service (see Meteorology section) determine the weather and wind conditions to be expected on your journey for the period of the flight. A commonly held misconception is that during an out and return journey on a reciprocal heading any headwind component will be cancelled out by the tailwind on the reciprocal leg. This is not true!!

Lets use a simple example, (to make the calculations simple we will use mph instead of knots). An aircraft is intending to fly out and return at 60mph:

- Each leg is 60 miles.
- Total time in nil wind conditions = 2 hours.

Now lets assume a 20mph tailwind on the out leg and a 20 mph headwind on the return leg:

- Groundspeed on the out leg is 60+20 = 80mph Flight time = 45 minutes.
- Groundspeed on the return leg is 6020 = 40mph Flight time = 1 hour 30 minutes.
- Total time is now 2 hours 15 minutes.

Similar (although to a lesser extent) results can be experienced with the effects of crosswinds. A direct crosswind will still contain a headwind component adding time to your flight.

Assuming the weather is favourable, make a note of the wind speed and direction at the altitude you will be using.

- Wind speed will be given in knots.
- Wind direction will be given in degrees true.

For the exercise to follow we shall say that we have:

- Wind 10 knots,
- Direction 045 true.

Note: Always bear in mind that meteorological information may differ quite markedly from actual conditions, particularly at low level. This is no reflection on the service, but rather the fickle nature of the atmosphere. In flight the pilot must develop the ability to assess the conditions for himself.

True Track

If we are to use our compass as an aid to navigation, we must make allowances for wind and direction. Start by finding the true track to your destination by measuring the degrees clockwise from True North longitudinal lines). This is called the True Track. For the exercise to follow we shall say that for example it is due east 090.

Consider the figure below. If the pilot of this machine simply follows a heading taken from the map to his destination, without compensating for the wind from his left he will never reach his goal. The wind will drift him to the right even though his compass heading remains constant.

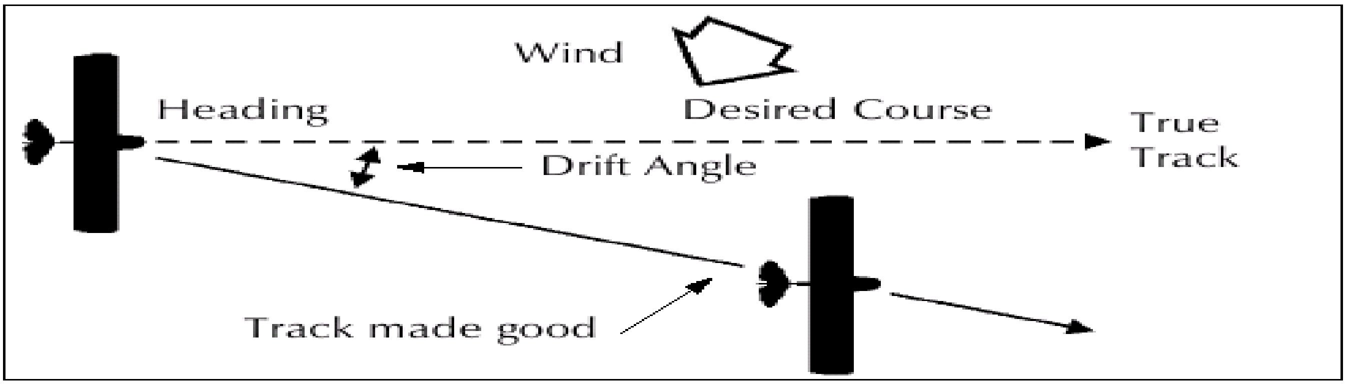


Fig. 113

The next figure shows a pilot who, with his destination in sight on the horizon, simply aims the nose of his aircraft straight at his goal. He will get to his destination, but only after a considerable detour caused by wind drifting him to the right of his desired path.

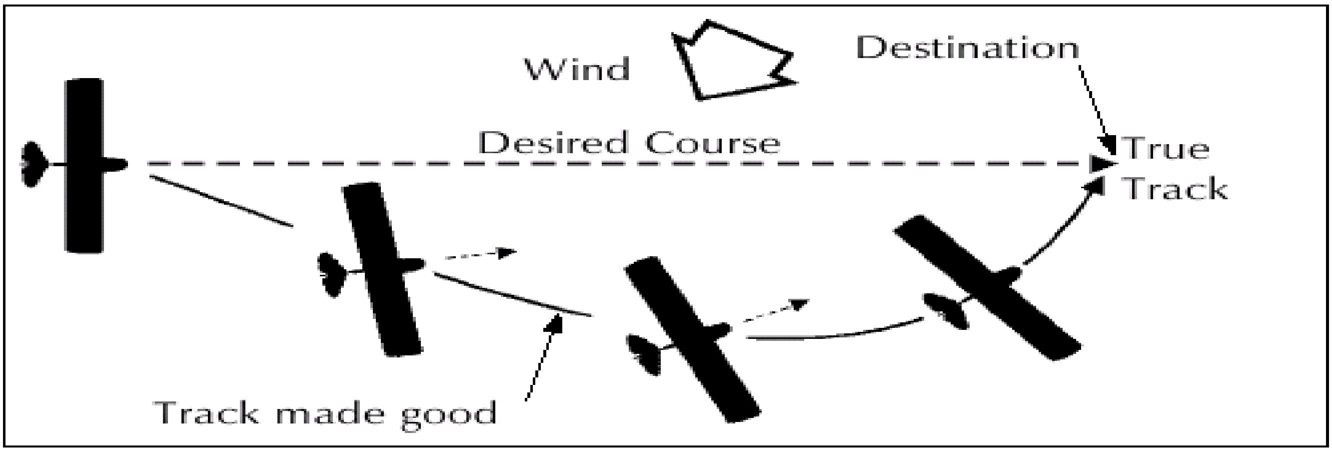


Fig. 114 The figure below shows a pilot who has visually, or by using a calculated compass heading, countered the effect of the wind drift and is making his way direct to his destination.

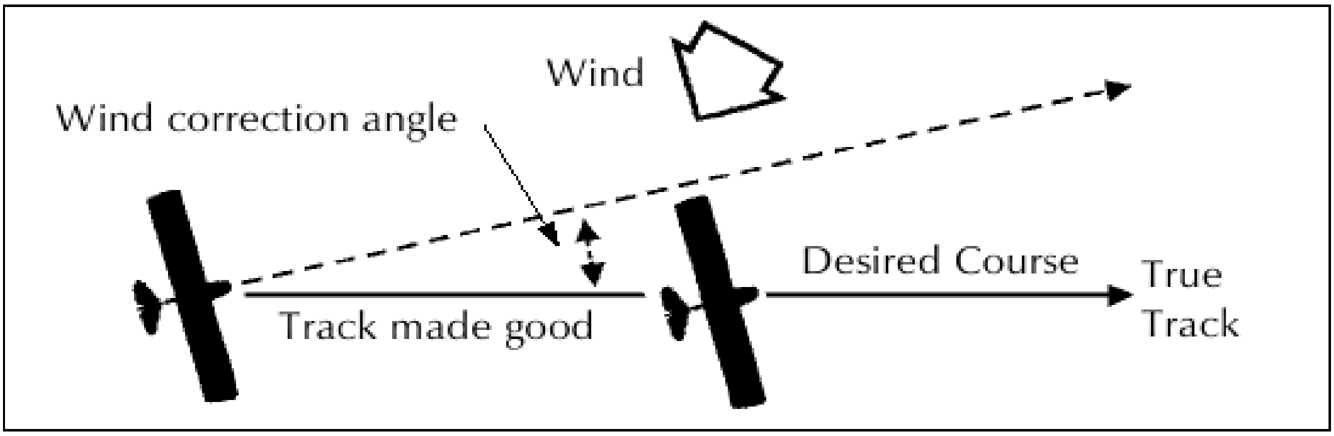


Fig. 115 How did the pilot calculate the drift and arrive at a compass heading to steer by? The method outlined below also told:

- Time the flight would take.
- Groundspeed.
- Fuel required.

The Wind Triangle

We need to know:

- Airspeed of machine.
- True Track.
- Distance.
- Wind Speed.
- Wind Direction.

We have assumed for this exercise that we have:

- True Track 090
- Distance 50 nm
- Wind Speed 10 kts
- Wind Direction 045
- Airspeed 40 kts

On a plain sheet of paper draw a vertical line representing north and south. (The various steps are shown on another page).

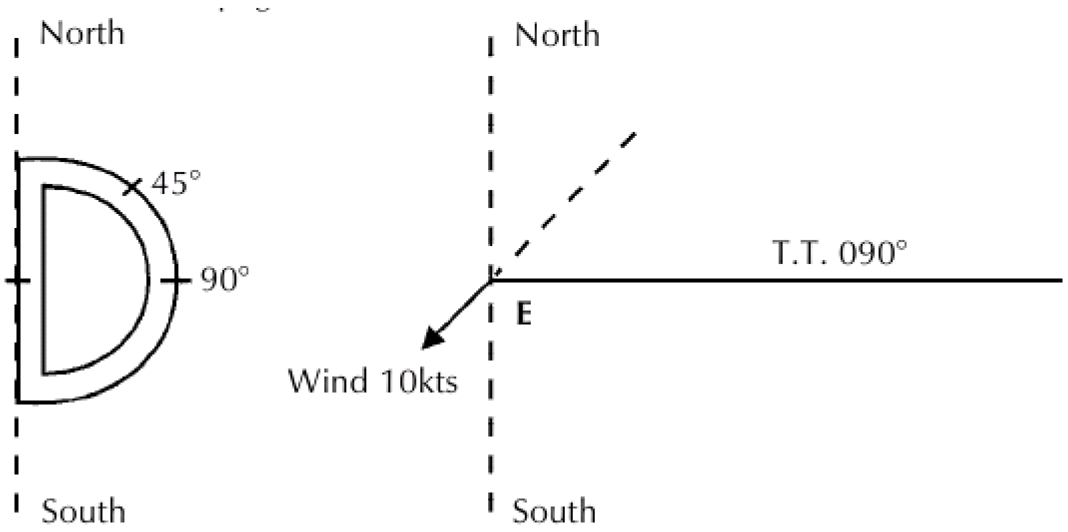


Fig. 116 Steps 1 & 2 & 3. Place your protractor's centre dot on the line and with the protractor orientated north and south, mark a point label ed "E" (point of departure) and make a dot at 90° (indicating true track) and another at 45° indicating wind direction.

With a ruler draw the true track line from "E" extending it somewhat beyond the dot at 90° and labeling it "TT 090°".
Next align the ruler with "E" and the dot at 45° and draw the wind arrow from "E" not towards 045 but in the direction the wind is blowing, making it ten units long to correspond with the wind velocity of 10 kts.

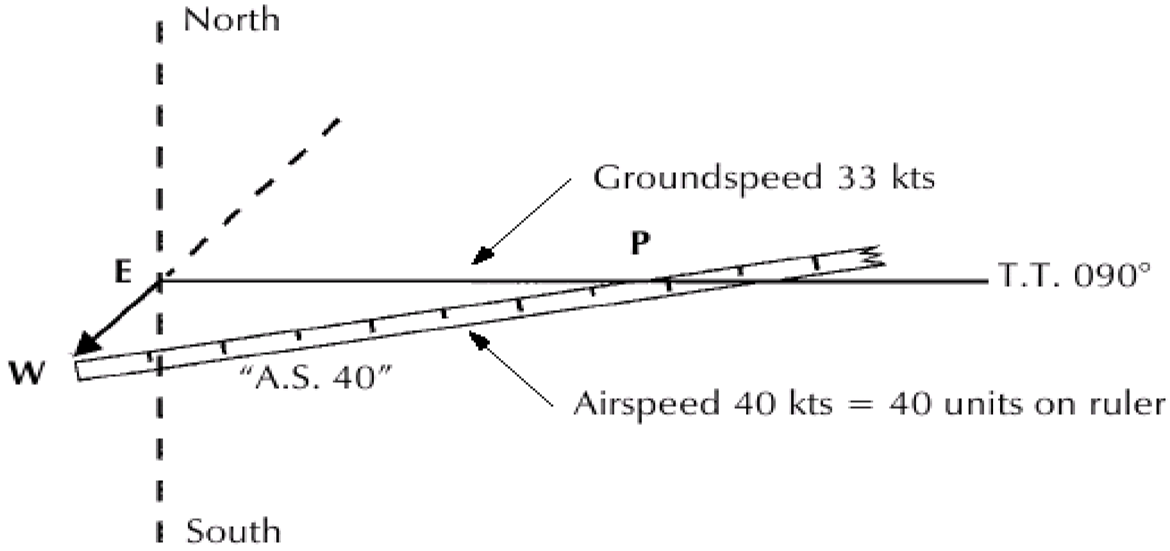


Fig. 117 Step 4.

Identify this line by placing the letter "W" at the end to show the wind direction. Finally measure 40 units on the ruler to represent the airspeed, starting from the end point of the wind line to intercept the True Track line.
Draw the line and label it "A.S. 40" (airspeed 40 kts).
The point "P" placed at the intersection represents the position of the microlight at the end of one hour. The diagram is now complete.
The distance flown in one hour (ground speed) is measured as the number of units on the true track line. (33 kts in our example.)

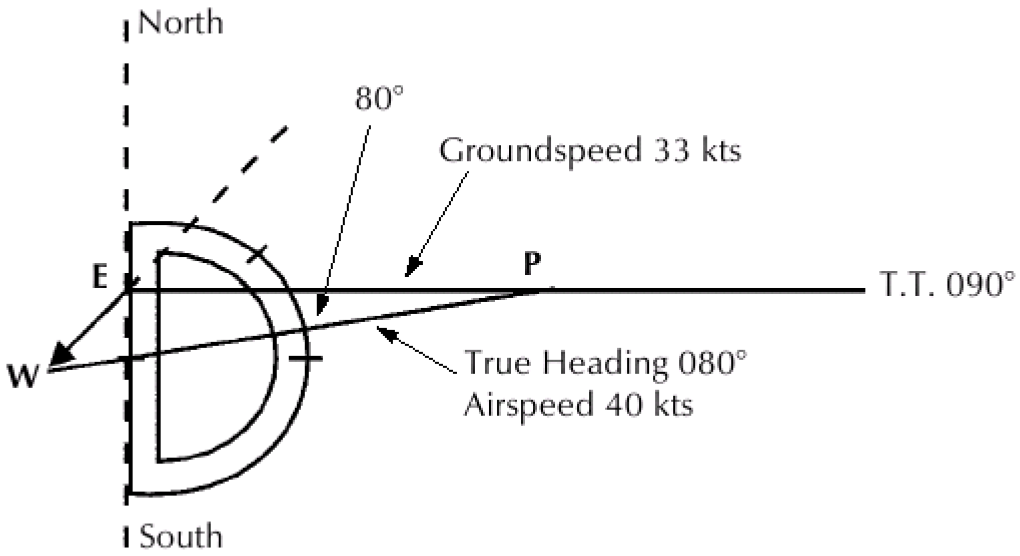


Fig. 118

The True Heading necessary to offset the drift is indicated by the direction of the airspeed line (A.S. 40) which can be determined in one of two ways.

- By placing the protractor along the north/south line, with the centre dot at the intersection of the airspeed line and north/south line, read the True Heading directly in degrees. (080 in our example.)
- Find the angle between the True Track line and the airspeed line at the intersection point "P". This is the drift angle which must be applied to the true track to obtain the True Heading.

In the example the wind correction angle is 10 degrees. If the wind blows from the right of the true track, the angle will be added, if from the left it will be subtracted. Thus, in the example given the wind is from the left, therefore subtract 10 from the true track of 090 making the True Heading 080.

After finding the True Heading, apply the correction for magnetic variation to obtain the Magnetic Heading.

With our example we shall say the variation is 19E. Therefore 080 - 019 gives us 06 1. The final correction is for deviation.

Your compass card wil show what heading to steer for 061 magnetic.

Flight Time and Fuel

If the distance to your destination is divided by the groundspeed you will find the time required for the flight. In our example:

- distance 50 nm
- groundspeed 33 kts

50 divided by 33 gives you 1.5 hours (or 90 minutes).

If fuel consumption is 15 litres per hour you will use 15x1.5 or about 22.5 litres.

Briefly summarised, the steps in obtaining flight information are as follows:

- True track: Direction of the line connecting two desired points, drawn on the chart and measured clockwise in degrees from true north.
- Drift angle: Determined from wind triangle. (Added to true track if the wind is from the right; subtracted if the wind is from the left.)
- True heading: The direction measured in degrees clockwise from true north, in which the nose of the aircraft should point to make good the desired path over the ground.
- Variation: Obtained from the isogonal on the chart. (Added to true heading if west; subtracted if east.)
- Magnetic heading: An intermediate step in the conversion. (Obtained by applying variation to true heading.)

- Deviation: Obtained from the deviation card on the aircraft.
- Compass heading: The reading on the compass which will be followed to make good the desired course.
- Total Distance: Obtained by measuring the length of the true track.
- Groundspeed: Obtained by measuring the length of the true track line on the wind triangle. (Using the same scale employed for drawing the diagram.)
- Flight time: Total distance divided by ground speed.
- Fuel Required: Predetermined litres per hour at cruise speed over the flight time. Allow a few extra litres for the climb to cruise.

Note: Additional fuel should be added for safety to allow for a diversion to another landing field, unexpected stronger head winds, getting lost etc.

Returning to Base Because of changing weather, or other unforeseen events, it may sometimes be necessary to return to the point of departure. Clearly if we were to simply steer a reciprocal heading, any drift would now be acting in the opposite direction and track could be very different to what is required.

The rule to achieve a reciprocal course is:

- Bear in mind the drift being compensated for.
- Take the reciprocal heading and subtract twice this drift if it was previously from the port.
- Add twice the drift if it was previously from the starboard.

Remember after the turn the nose of the aircraft will not be pointing in the exact opposite direction to that before the turn.

Flying with a Compass

An aircraft such as a microlight does not always make a very steady platform on which to mount a compass. In turbulence the compass may swing about. Try to average this out, rather than chase the compass. Depending on the type of compass, most indicate incorrectly when being accelerated or decelerated, so read the compass during periods of stable airspeed.

Map Reading

The ability to plan a flight and set off with an accurate compass heading is very useful. However, it is important to bear in mind that without good map reading to back it up, navigating a microlight purely by following a compass heading is foolish. Should the wind change in strength or direction the compass heading is made useless, and unless you are carefully following your progress along the route marked on your map by map reading, you would have no idea at al of any change.

The first thing you would know was that at the calculated time your destination would fail to appear! Therefore the ability to map read is vital.

Assuming you have studied the map you will have no trouble recognising al the symbols on it. Also, by studying the route you will be flying and the surrounding area, you will have a good idea even before takeoff of what you should expect to see.

Read from the map to the ground and then from the ground to the map.

Remember the higher you are the further you can see, but keep in mind that at more height some features become less distinct. Below 3,000ft AGL this is seldom a problem.

Do not waste time looking for indistinct features if other more easily recognisable features are around.

Always positively identify a feature once you think you have sighted it, by checking others nearby and seeing that it fits.

Mark intervals of time along the track on your map, and note whether your groundspeed is as expected. Therefore make a note of the time you get airborne in the right direction along track.

Keep reviewing your progress with regard to fuel consumption to ensure there is sufficient to complete the trip.

Navigating Without a Compass

Preparation for a cross-country flight without a compass is the same as for a flight with a compass.

The pilot should still determine the route to be flown, airspace considerations and weather. Drawing a wind triangle will give an idea of groundspeed, time, drift, and fuel required. All this information should be gathered before the flight.

The difference now is that we do not have a compass heading to steer by, therefore we must study the map and note the prominent features along the route. These need not be actual y on the true track if they are sure to be easily seen like a small lake or pond, racecourse, town, open cast mine etc.

Initially what is needed is a good prominent feature just a few miles from the takeoff point, preferably visible from the takeoff point. This is likely to be a small town, major intersection or similar, and should be on the true track.

Once airborne one can make for this feature, al owing for drift as required to keep on true track.

This first stage, which may include the climb to cruise altitude, gets the flight started on track.

From here, map reading from feature to feature along the route continues. Keep looking for the next feature to appear as you go.

However, it is vital that the first feature you make for is prominent and positively identified.

If you have mistaken this first feature and started off in the wrong direction, naturally the next features will not appear where they should. This will tell you immediately that your heading is wrong and you should still be very near your takeoff point and be able to return and look again for the correct feature while still having the option of landing.

It is a good idea as you head off from your takeoff field, to look back occasionally as you go to keep an idea of what the place would look like to return to if need be. Of course, if you have taken off from a controlled airfield then be sure you arranged for a possible return.

Use prominent features backed by smaller features. For example, if your track takes you three miles abeam a town, check that you are three miles abeam by checking a road intersection or something below.

Prominent features can easily be used to provide an approximate fix, accurate to within a couple of miles. From this position a more exact fix can be made from smaller details nearby. An example of this method is outlined below, using the simplified map shown.

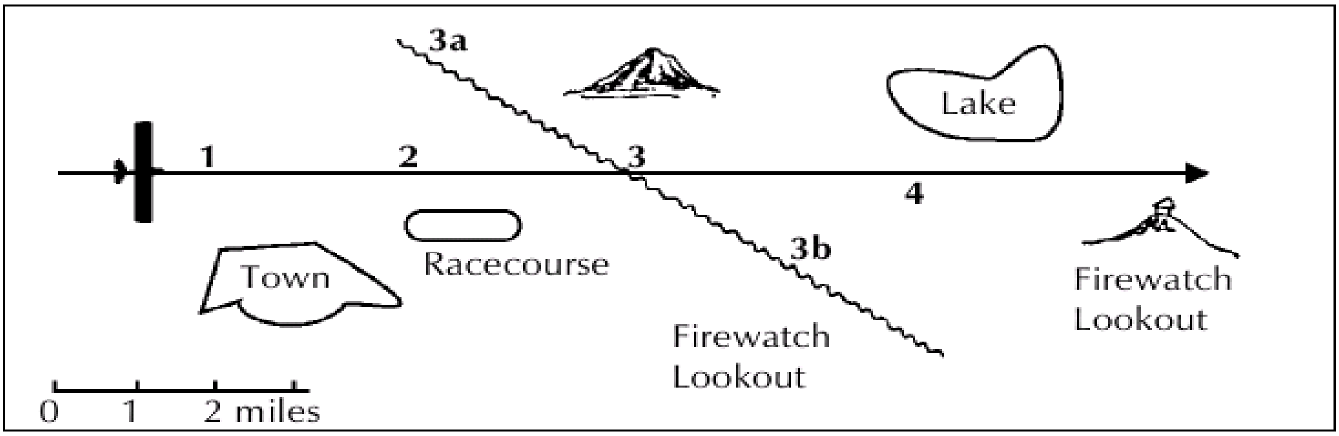


Fig. 119 Along this section of route we shall pick up from a position nearing the small town. We know our track will take us about a mile to the left of the town, so we continue in this way. As we reach position 1 abeam the town we should have the racecourse in sight just ahead and we should see that our track will take us about a half mile left of it.

Arriving at position 2 with the racecourse on our right, we should see the high ground peak about 40 degrees to the left of track at about three miles. We may see the power pylons and their wires converging to cross our track up ahead.

At position 3 we should have crossed the pylon line when the same high ground is almost exactly 90 degrees to the left of our track. If we have crossed it when the peak was still a little ahead (3a) we can deduce that we are to the left of track; if it was a little behind us as we crossed the wires (3b) we can tell that we are to the right of track, and so on to the next features.

In this fashion we can navigate with complete accuracy provided:

- We have studied the map before flight.
- We map read carefully recording progress along the track on the map as we go.
- We always have a positively identified feature in sight and another one ahead as the next reference.

This method is really quite simple and with practice becomes second nature.

GETTING LOST

Even though you may be the most meticulous of pilots, it is quite possible that on occasion you may find yourself unsure of your whereabouts. A missed or mistaken fix, or wind change during flight can easily cause confusion.

If you have been marking your progress frequently and if you have accepted your predicament immediately without hesitation, you should be able to have at least an educated guess as to your position by projecting on your map your expected progress since your last known position.

This gives you at least a locality on your map to find recognisable features.

- If you can get back to your last known position, you can try navigating from there.
- If you are really lost, or confused, find a suitable area and land.
- Secure the machine and find out where you are, from someone.
- Do not continue blindly, wasting fuel and daylight. Land and get things sorted out.

If you think you may have entered controlled airspace accidentally, land as soon as possible. Likewise, if you become lost knowing you are in controlled airspace, land, find out where you are and advise the air traffic unit of your intentions. If you have been given a clearance, this may have to be revised.

Useful tips:

- Write down al relevant information tidily, to be easily referred to in flight.
- When following a road or railway (or any prominent feature) always keep it on the left.
- Do not continue if weather conditions or failing light gives trouble.
- Avoid causing a nuisance by flying low.
- Beware of the lee of terrain and ground obstacles.
- Beware of power wires or any other wire especial y on landing.
- Always keep an emergency landing field in range.
- Keep a close check on fuel consumption.
- File a flight plan or advise someone of your intentions and route.
- Lookout for other aircraft.

Navigation in Bad Weather

It is not at al uncommon for weather conditions to deteriorate during the course of a flight.

The pilot should constantly monitor the conditions and anticipate any problem with the weather before it becomes serious. If the trend is toward worsening weather, or you suddenly find conditions have gone bad, then you must decide the best course of action.

Depending on the situation, some of the possible options are return to point of departure, divert to another destination with better weather, or make a precautionary landing.

During any cross-country flight keep these options in mind at all times.

Some of the facets of bad weather which can be a hazard to safe flight and navigation are:

- Lowering cloudbase.
- Reduced visibility.
- Rain or hail etc.
- Increase in wind strength.
- Increase in turbulence.

It is usually true that deteriorating weather involves one or more (often all) of the above. Lowering cloudbase has the effect of forcing one to fly lower to maintain clearance form the ceiling.

Reduced visibility makes map reading difficult by restricting or obscuring features on the ground.

Rain or hail etc can be very damaging to airframes, particularly propellers.

An increase in wind strength may drastically reduce the range of a microlight or render the landing field at the destination unsafe.

An increase in turbulence may increase the pilot workload and possibly affect the controllability or overstress the microlight.

All of these conditions are serious in themselves and demand action, but when several are present the potential for danger is greatly increased. This is due to the cumulative effect, for example, a lowering cloudbase forces our pilot to fly lower and over unfamiliar rough terrain.

Visibility becomes a problem with drizzle and wisps of low cloud, making map reading very difficult. Add to this strong wind and moderate to severe turbulence at the low level our pilot is flying, and the situation is rapidly getting out of hand.

Our pilot is now unsure of his whereabouts and the turbulence is both mentally and physically tiring. It is not long before he is completely lost. The ceiling drops further and whilst flying very low over unfamiliar ground in poor visibility, he flies into a set of high tension wires strung across a valley.

The above scenario, grim as it may seem, is actually a fairly typical sequence of the events leading up to a weather related accident.

It is easy to say to ourselves, we would never get into that situation, which of course is the remedy to avert disaster, but it takes a certain discipline to take the appropriate action at the right time.

The right time, of course, is to take action at the first sign of trouble.

In this way, a relatively simple decision is made before any danger arises. Navigating in poor weather is full of risks and best avoided.

Whilst on a cross-country keep a constant check on:

- Your whereabouts, through careful map reading.
- Your progress with regards to fuel endurance remaining and time required to reach your destination.
- Weather conditions, not only ahead, but to each side and behind, in case of a possible diversion or return.
- Suitable landing fields in case of emergency.
- Other aircraft. Keep a constant Lookout.

10. Radio

INTRODUCTION

References

- AIP Mongolia Volumes 1 and 4 in printed form
- CAA Advisory Circular AC 172-1 Radiotelephone Manual (3.73 MB)
- CAA Rules available at www.mcaa.gov.mn

Flight in controlled airspace or operating from controlled and uncontrolled registered airfields can be made much simpler with the use of radio- in fact you may be refused permission to enter controlled airspace without a radio. Mandatory Broadcast Zones (MBZs) and Common Frequency Zones (CFZs) also require the pilot to broadcast position and intentions to other traffic in the zone. Being in direct communication with Air Traffic Controllers, Information Units, Ground stations and other aircraft helps ensure flight safety and efficient use of airspace.

With a radio you can get clearance into or out of controlled airspace and airfields, obtain weather information en route, lodge or cancel flight plans, and maintain awareness of other radio equipped traffic in your general vicinity, etc.

You should refer to your owners manual for instructions on how to adjust frequencies and other operational parameters of the radios you operate.

Microlight aircraft do not require a radio by law but their use is strongly advised and the holding of a current FRTO rating is mandatory for Advanced National Certificate holders.

The requirements for use of radio are:

- The pilot must be the holder of a current Flight Radio Telephone Operator rating (FRTO). This rating can be gained by the pilot passing an exam based on the CAA approved syllabus, and a practical training exercise and assessment conducted by an Instructor. Approved bodies for holding these exams are ASL, SAC and X-Team. Written test papers and syllabus for these organizations are assessed by CAA against AC61-3. Your nearest club or X-Team can advise on the best procedure to gain a rating.
- Before a microlight pilot is flight tested for an Advanced National Certificate the pilot must hold an FRTO rating.

Actual use of the radio can at first seem difficult as you strain to understand and respond to instructions. To help get used to the phraseology it can be worthwhile to arrange to spend some time listening to other pilots at a ground station and practice calling on a microlight 'chat frequency'. A few hours of this can do wonders for your understanding of what is expected of you in practice.

Note that 130 is NOT a chat channel- It is used as a common frequency for traffic at unattended airfields, and can get quite busy on fine weekends. Do not clutter this frequency with irrelevant chatter. Go to an unused frequency such as 133.375 for radio practice and general chatter.

Remember to always keep a good listening watch on the radio, as this not only keeps you informed of other airspace users movements, but also helps to ensure that you respond promptly when called by an ATS Unit.

THE BASICS

The following provides the basics of radio operations in aircraft. A deeper understanding of each bullet point is not a requirement but it is in the interests of the pilot to understand the basics further.

- Aircraft radios operate on the VHF (Very High Frequency) band 30 MHz-300 MHz
- The usual frequencies used today range from between 118.0 and 135.975 MHz.
- The emergency VHF frequency is 121.5 MHz for both voice transmission and your ELT.
- Before operating your radio, and especially before operating in controlled airspace, check what radio frequencies are in use and write them down where they can be easily referred to.
- VHF radio signals travel at the speed of light and in a line of sight.
- The higher you are, generally, the better the coverage.
- Your radio is a transmitter and receiver(Transceiver)
- Your voice is transmitted via your microphone and your headset is used to listen to calls.
- You must be on the same frequency as the aircraft or base you transmit to.
- When you transmit on that frequency -NO ONE ELSE CAN
- Keep calls short and to the point
- Think about your message before you transmit, speak clearly and slowly.

- Turn your radio on after engine start and turn it off before engine stop - this protects the radio from electrical damage.
- Aircraft may not enter controlled airspace without permission from ATC.
- Standard phraseology must be used as detailed in AC172-1. Accurate and concise radio transmissions are an important element of good airmanship.

How your VHF radio works

The VHF radio transmits and listens to transmissions that occur at the working frequency , the base frequency used in transmissions is known as the carrier . The transmitter takes audio from the microphone / intercom and superimposes it over the carrier, and this is transmitted through the aerial as radio wave energy. The receiver listens on the same working frequency and separates the incoming audio from the carrier making it available for the intercom / headset / speaker.
VHF signals are line of sight and don't tend to bend around objects like mountains. They do travel for a long distances even when the transmitter is a low power unit like a hand-held , ie 0.6 watts. Quality of the transmission and distance transmitted are largely dependent on quality of the installation especially the aerial setup and quality of the microphone / intercom interface to the radio.
VHF transmissions will be affected by any object between the aerials of the two stations. In some installations transmissions in some directions may be blocked or degraded by:

- Parts of the airframe.
- The quality and the strength of the transmitted signal
- What is between the two stations such as airframe parts, terrain, meteorological interference.
- The quality of the receiver, including the intercom and headset that it passed through.
- Electrical noise from ignition, alternator or other electrical or electronic equipment

Generally weak signals will be more readable the higher the aircraft flies. An incoming weak signal may often be successfully heard by adjusting the squelch control.

HF High Frequency Radio

HF transmissions bounce off the higher atmospheric layers. They were used extensively for offshore operations and mountainous communication. The clarity of transmissions is more variable than VHF but the range in difficult conditions is much better. HF radios are becoming less common as satellite telephones and digital services have filled the role that was needed in the past.
HF radios often had extendable aerials and were generally larger units than VHF radios.

VHF Radio Controls and indicators

On / Off Switch - Used to power on the radio. In most aircraft the Master Switch must also be ON. It is usual to protect your radio from engine starting voltage fluctuations by switching it on after the engine is running. It is also usual practice to switch the radio off prior to engine shutdown.
Frequency Selection and Display - VHF radios transmit and receive in the 118.000 MHZ to 136.975 MHZ range and many can also receive-only from 108.000 MHZ to 117.975 MHZ. Modern 760 channel radios allow frequency selection in 0.025 MHZ increments while older 360 channel models can be selected in 0.05 MHZ increments. Some preset frequency VHF radios have a number of frequency crystals installed, typically 5 - 10, and these are the only frequencies available on the radio. Fixed frequency radios are often found as base stations and are less useful as operational aircraft radios.

Examples of frequency steps

720 Channel	**360 Channel**	**180 Channel**
119.1	119.1	119.1
119.125	-	-
119.150	119.15	-
119.175	-	-
119.2	119.2	119.2

Most published frequencies in use in Mongolia fit within the 180 channel model with only a few that require the 360 channel model.

There are many different ways that the radio manufacturer may have you select the working frequency.

Modern panel mount radios tend to have one or more rotary or push switches and a display panel, LCD or LED, that indicates the frequencies. Often they show a working frequency and a standby frequency and will have a switch or button to swap the working and standby. In this case the frequency selection switches will usually change the settings on the standby frequency.

Delcom hand-held radios have an arrangement of thumbwheel switches that select and display the working frequency acting on the Tens / Units and Tenths with a separate switch for selection of an optional add on of 0.000 , 0.025 , 0.050 or 0.075. These radios only have one working frequency.

Most other hand-held radios have a keypad and a LCD that shows the frequency selected. Typically a quick method of changing often used frequencies or toggling working and standby frequencies is available.

Having a working frequency and a standby frequency is very useful as you can be prepared in advance to toggle between two frequencies. eg Swapping between Tower and ATIS , local traffic and en route information, ground and tower at a controlled airfield. Toggling minimises the time required to swap frequencies and reduces the possibility of setting the radio off the required frequency.

Understanding how your radio selects the 0.025 MHZ steps is important as inadvertently selecting a 0.025 step when not required is a common cause of being off the required frequency- particularly with the Delcom style radios.

Volume Control - Sets the volume level that feeds your intercom / headset / speaker (incoming transmissions as audio volume)

Squelch control - This will be a graduated adjustment knob or an ON/OFF switch. Often it will be incorporated into the volume control as a pull push, a second adjusting rotary graduated control or as part of the on/off power switch. Normally your radio will be silent. ie no hissing or background noise. When another station transmits, carrier sense circuitry in your radio activates the audio output and you can hear the audio of the transmission. The squelch control modifies the threshold or bypasses the trigger circuit. This control is used to check the volume setting of your radio (incoming transmission as audio volume) , assist in attempting to receive weak signals that fade in and out or are broken , and in the case of variable adjustment control set the trigger level.

Carrier On / Transmit - Usually a LED , LCD or light that shows while your radio is transmitting. This is useful to verify that your transmit switch is functioning correctly and especially that it is stopping transmissions when released. Stuck Mike or continuous transmission is a serious situation that should be monitored and prevented. It stops all incoming transmissions (your radio can only receive or transmit, not both at once) and blocks or degrades, depending on the relative power and proximity of stations , all of the other users of the frequency. It also broadcasts every thing you are saying!

Transmit Button - Blocks the receiver, livens the mike / intercom and transmits.

Microphones, headsets, push-to-talk and intercoms

There are several arrangements commonly found in aircraft installations.

Microphone and speaker - This is becoming less common. A microphone fitted with a Push-to-talk button is used to transmit and a speaker in the cockpit is used to listen to received messages. Handheld microphones are usually held touching just above the top lip , or just below the bottom lip , depending on microphone design. The microphone is only active when powered up by the PTT.

Headset connected direct - Quite common especially in single and two place aircraft. A push to talk button livens the headset microphone to transmit and the received messages are heard in the headset ear phones

Radio with intercom - This type of installation can be thought of in four logical components. The radio, intercom, PTT switch and the headset. Some radios also provide an intercom function as a built in function. Many intercoms have a fail safe mode so that if they are powered off they behave like a headset directly connected to the radio- usually on the Pilot headset. Usually the intercom will have separate squelch and volume controls. Voice activation is usual and the intercom will be silent when there is no cockpit communication. In this installation the PTT button triggers the transmitter and enables the audio from the intercom through to the transmitter.

It is common for intercoms to manage several audio inputs. Multiple radios, other navigation aids, stereos and other devices.

Headsets It is important that the headset microphone is correctly positioned. Usually the microphone works most effectively when it is quite close to the bottom lip. Many headsets have a volume control for the earphones.

THE PHONETIC ALPHABET AND USAGE

This must be learnt as it is the basic of all aviation communication.

The Alphabet

The syllables to be emphasised are in CAPITALS

Message	Word	Say
A	ALFA	AL-fah
B	BRAVO	BRA-vo
C	CHARLIE	CHAR-lee
D	DELTA	DELL-ta
E	ECHO	ECK-oh
F	FOXTROT	FOKS-trot
G	GOLF	GOLF
H	HOTEL	ho-TELL
I	INDIA	IN-de-ah
J	JULIETT	JEW-lee-ETT
K	KILO	KEY-lo
L	LIMA	LEE-ma
M	MIKE	MIKE
N	NOVEMBER	no-VEM-ber
O	OSCAR	OSS-car
P	PAPA	pah-PAH
Q	QUEBEC	key-BECK
R	ROMEO	ROW-me-oh
S	SIERRA	see-AIR-ra
T	TANGO	TAN-go
U	UNIFORM	YOU-nee-form
V	VICTOR	VIK-ta
W	WHISKEY	WISS-key
X	X-RAY	ECKS-ray
Y	YANKEE	YANG-kee
Z	ZULU	ZOO-loo

Numerals and Altitudes

The following is the pronunciation of numerals during radio calls

Message	**Say**
1	WUN
2	TOO
3	TREE
4	FOW-er
5	FIFE
6	SIX
7	SEV-en
8	AIT
9	NIN-er
0	ZE-ro
DECIMAL	say DAY-see-mal
THOUSAND	TOU-sand
HUNDRED	HUN-dred

Here are a few examples of flight levels Only the whole hundreds and thousands are given as HUNDRED or TOUSAND.

Number	**Spoken as**
10	WUN ZE-ro
65	SIX FIFE
300	TREE HUN-dred
783	SEV-en AIT TREE
4000	FOW-er TOU-sand
11000	WUN WUN TOU-sand
25000	TOO FIFE TOU-sand
25500	TOO FIFE TOU-sand FIFE HUN-dred

When giving radio frequencies, the word "DECIMAL" (pronounced DAY-see-mal) must be used. eg: 118.1 - WUN WUN AIT DAY-see-mal WUN

Time

When transmitting time we generally only say the minutes of the hour. However, if there is any possibility of a possible misunderstanding, then the hour should also be transmitted.
For aviation we use the 24 hour clock, with the day beginning at 0000 hours and ending 24 hours later at 2400 hours.
For example:

- 9:15 am is 0915. Spoken as WUN FIFE (or ZE-RO NIN-er WUN FIFE)
- 1:00 pm is 1300. Spoken as WUN TREE ZE-RO ZE-RO
- 6:20 pm is 1820. Spoken as TOO ZE-RO (or WUN AIT TOO ZE-RO)

Common words and phrases

ACKNOWLEDGE	Let me know you have received and understood this message
AFFIRM	Yes
APPROVED	Permission granted
CANCEL	Annul the previously transmitted clearance (from ground)
CLEARED	Authorized to proceed
CORRECT	That is true or Correct
CORRECTION	An error was made in the last transmission-this is the correct message
DISREGARD	Ignore
GO AHEAD	Proceed with your message
HOW DO YOU READ	What is my readability (ref section on readibility)
I SAY AGAIN	I repeat for clarity
NEGATIVE	No or permission not granted, not correct
OVER	Not normally used in VHF communication
READ BACK	Repeat all back to me as received
REPORT	Pass me the following information
REQUEST	I should like to know or wish to obtain
ROGER	I have received you last message. NOT to be used in conjunction with READ BACK
SAY AGAIN	Repeat all or part of last transmission
SPEAK SLOWER	Slow down your speech
STANDBY	Wait for my call
UNABLE	Unable to comply with your request or instruction
WILCO	I understand your instruction and will comply

WHAT IS THE RADIO USED FOR?

The aircraft radio is used to convey the following types of messages.

- Weather Reports
- Aircraft Position
- Aircraft problems
- Comms with other aircraft
- Comms with land based station
- All station transmission
- Declaring an emergency

AIRCRAFT CALLSIGNS

All stations have callsigns.
A call sign may be permanent or change such as a flight number of a passenger service flight.
There are three types used in Mongolia.

- **Aircraft Type and Registration Letters/digits** The aircraft type followed by the last 3 letters of it's registration. eg **Tecnam PXI**
- **Telephony Designator and registration letters/digits** The aircraft operator (Air Mongolia or X-Team) followed by the 3 registration letters or 4 digits spoken phonetically.
- **Telephony Designator and Flight Identifier** The aircraft operator followed by the 3 flight numbers or letters.

Only the first type is used in Microlight and aero-club type aircraft. Commercial operators use the other methods of identification.
After the initial communication, you may drop the type and just use the 3 registration letters or 4 digits.

BASIC CALL STRUCTURE.

Initial calls to attended ATS stations always start with the destination station, followed by the calling station identification.
Calling an attended station example

- **NISLEG TUV TOWER, MICROLIGHT 9001**Initial call
- **9001, NISLEG TUV TOWER** Response

You then reply with your message starting with your callsign.

- **9001, 15 MILES NORTH OF FIELD AT ONE THOUSAND, REQUEST OVERHEAD REJOIN**

If you make an error while callling ,stop the call and restart by saying **CORRECTION**

- **9001, 15 MILES...CORRECTION 10 MILES NORTH AT ONE THOUSAND...**

You will notice that once communication is established with the ground station it is not necessary to include the ground station callsign in subsequent transmission. Since all communications are between the ground station and an aircraft, the ground station is assumed to be a party to the communication, and the aircraft callsign confirms which aircraft the communication relates to.
When broadcasting to traffic at an unattended airfield or in a Mandatory Broadcast Zone or Common Frequency Zone, it is important to identify who you are addressing at the start of each transmission. Common frequencies such as 130 MHz apply to many different airfields and it becomes very important to confirm which destination stations are being called.

- **NISLEG TUV TRAFFIC, 9001 DOWNWIND FOR TOUCH AND GO RUNWAY 36**

READBACK

Readback is used when you are required to confirm what a station has asked you to do. This is important when operating in controlled airspace, where you need to accurately repeat (readback) the instructions from the controller.

- **PAPA-XRAY-INDIA CLEARED FOR OVERHEAD REJOIN, REPORT OVERHEAD** clearance given
- **CLEARED FOR OVERHEAD REJOIN, REPORT OVERHEAD, PAPA XRAY INDIA** readback

READABILITY

Readability is the measuring of the ability of radio transmissions to be heard and understood. The following scale is used to quantify readability

Scale	Pronounced	Meaning
1	Wun	Unreadable
2	Too	Readable now and then
3	Tree	Readable,but with difficulty
4	FOW-er	Readable
5	Fife	Perfectly Readable

LISTENING ON THE RADIO

While a lot of radio traffic will occur most of it will not be for you . If you think you have missed a call say

- **PAPA-XRAY-INDIA, SAY AGAIN**

Any message for you will begin with your callsign.
If you hear a station trying to communicate with another station unsuccessfully you may ask the calling station if you can be of assistance . The calling station may ask you to call the receiving station on his behalf, but keep in touch with the calling station.

POSITION REPORTING

One of the most important uses of the radio is position reporting . You may wish to report your position for the following reasons

- Clearance request to ATC to enter or leave controlled airspace
- Traffic Avoidance- Let others know where you are
- Radar Identification- Lets the controller confirm that his blip is you
- Search and Rescue - Lets ATC or any other listeners know your last known position

It is good practice to broadcast your position every 15 to 30 mins when on a cross country flight and when you enter an area of heavier traffic movements such as controlled and uncontrolled airfields. Let other aircraft know you are around, but make your calls short and give accurate information.

When you give a position report information should contain the following

- Your station callsign
- your position and altitude ie. overhead a town or some feature
- heading and track
- time at which you expect to be at a certain position
- what your ETA is for your destination.

As much microlight flying is carried out in VFR conditions in uncontrolled airspace (Class G Airspace) reporting of prominent ground features is very important.

An example of a position call may be

- **SKY FRIEND TRAFFIC, PAPA-XRAY-INDIA, 15 MILES NORTH EAST OF SKY FRIEND, WUN TOUSAND FIFE HUNDRED FEET, OVERHEAD REJOIN ETA 25.**

ETA 25 means 25 minutes past the present hour.

TYPICAL RADIO CALLS- Uncontrolled airfield

Taxying

- **NISLEG TUV TRAFFIC, PAPA-XRAY-INDIA, TAXIING TOO FIFE**

At runway, about to roll

- **NISLEG TUV TRAFFIC, PAPA-XRAY-INDIA LINING UP TOO FIFE, CIRCUITS** circuits
- **NISLEG TUV TRAFFIC, PAPA-XRAY-INDIA LINING UP TOO FIFE, VACATING TO THE NORTH** vacating

About to return to field

- **NISLEG TUV TRAFFIC, PAPA-XRAY-INDIA 8 MILES SOUTHWEST, ONE THOUSAND SEVEN FEET, WILL JOIN OVERHEAD**

Overhead

- **NISLEG TUV TRAFFIC, PAPA-XRAY-INDIA OVERHEAD ONE THOUSAND FIFE HUNDRED, WILL JOIN LEFT HAND DOWNWIND TOO FIFE** It is not necessary to say “letting down on the non-traffic side” as this is part of the standard procedure.

Joining

- **NISLEG TUV TRAFFIC, PAPA-XRAY-INDIA LEFT HAND DOWNWIND TOO FIFE FOR FULL STOP**

Finals

- **NISLEG TUV TRAFFIC, PAPA-XRAY-INDIA FINALS TOO FIFE FOR FULL STOP**

Note. Do not ask “Any traffic?” NORDO aircraft can not reply, others may not or, if several aircraft present, may all try to speak at once.

On the other hand, for those already in the circuit, it is good practice to report your position when you hear an aircraft joining – this gives them a heads-up on the runway in use and potential traffic."

RADIO SERVICES

ATIS

Some Control Towers have an "ATIS" (Automatic Terminal Information Service) facility. This is a continuous tape of relevant weather and runway information which a pilot may tune to on a special radio frequency. (In the case of ULN, 125)

The Information is updated each time there is a change in the situation, and each change is given a letter of the alphabet as a title to enable the Controller to check that you are in receipt of the correct ATIS.

A TYPICAL ATIS IS :-

"'ULN TERMINAL INFORMATION ALFA ISSUED AT ....UTC

EXPECT VOR/DME APPROACH RUNWAY 16

(May be remarks about runway serviceability or work on the airfield)

SURFACE WIND 160 degrees, 10 KNOTS

VISIBILITY 10 KILOMETERS, HAZE

CLOUD FEW 4 TOUSAND FEET

TEMPERATURE 14 DEW POINT 4

QNH 1013

FORECAST 2000FT WIND 140 MAGNETIC 20 KNOTS

ON FIRST CONTACT WITH ULN TOWER NOTIFY RECEIPT OF ALFA.'"

Remember when you confirm the receipt of a particular ATIS you must read back the QNH.

When the tower is off watch an "OFF WATCH" message is transmitted.

All ATIS and AWIB transmisions give wind direction in magnetic.

e.g.

"'ULN TOWER IS OFF WATCH

USE UNATTENDED PROCEDURES ON 118.1

TERMINATE FLIGHT PLANS ON 124.8

ULN TOWER WILL RE - OPEN WATCH AT ....UTC'"

This "OFF WATCH" message is handy for finding out what time the controller will commence duties. If you have started flying before his hours of attendance, when the controller announces that control has commenced if you are inside his controlled airspace, give a position report and tell him what you are doing so he can get a picture of the traffic in his area.

TYPICAL RADIO CALLS- Controlled airfield

The rules for operating in controlled airspace are in fact quite simple

- request and receive clearance from ATS before you do anything
- readback your clearance to confirm
- if you cannot comply with your clearance then ask for an alternative you can comply with
- do as cleared
- keep your transmissions clear and precise

It can sound quite overwhelming to start with, but the phraseology is quite standard. It pays to spend some time listening to the RTF to get familiar with the phraseology and the particular patterns used by that ATS facility.

Some clearances can be quite complex (reporting position, altitude, QNH, other traffic, special instructions, etc)- it helps to have a notepad to jot the important ones down so you can remember them for readback and action. If you are unclear- ask. Better than guessing and getting it wrong.

Taxying

Aircraft	ATS	Comments
Murun Tower, microlight 9001		initial contact
	9001, Murun Tower	ATS response
9001, request taxi clearance to vacate west, I have information Whiskey, wun zero wun tree		your request ATIS information received
	9001, taxi to holding point Delta for runway two seven, Whiskey is current	your taxi clearance runway in use ATIS confirmation
9001, holding point Delta, for runway two seven		your readback

Ready to depart

Aircraft	ATS	Comments
9001 is ready		ready for takeoff
	9001, vacate west not above wun thousand feet, call vacating the zone, cleared for takeoff runway two seven	your takeoff clearance route and altitude further instructions go!
9001, cleared runway two seven, not above wun thousand wilco		your readback ... ... will call vacating the zone

Vacating the zone

Aircraft	ATS	Comments
Murun Tower, 9001 clearing your zone to the west		your call clearing the zone
	9001	ATS acknowledgment

Entering the zone

Aircraft	ATS	Comments
Murun Tower, microlight 9001		initial contact
	9001, Murun Tower	ATS response
9001, fife miles west at wun thousand feet,request joining instructions, I have information Xray, wun zero wun two		current position and altitude your request ATIS information received
	9001 cleared to enter the zone, not above wun tousand fife hundred feet, join left hand downwind runway two seven, Xray is current	your entry clearance altitude instructions ATIS confirmation
9001, not above one tousand fife hundred, join left hand downwind runway two seven		your readback
	9001	ATS acknowledgment

Joining the circuit

Aircraft	ATS	Comments
9001, joining left hand downwind for two seven		your joining/downwind call
	9001, continue approach, number two	your circuit clearance
Number two, 9001		your readback

Landing

Aircraft	ATS	Comments
9001, finals two seven		your position
	9001, cleared to land runway two seven	your landing clearance
9001, cleared to land		your readback
DO NOT LAND WITHOUT CLEARANCE, if it has not been given by short final- ask for it!		

Clearing the runway

Aircraft	ATS	Comments
	9001, clear left to the club	your taxi clearance
9001, left to club		your readback

FLIGHT PLANS AND SARWATCH

Flight Plans

VFR flight plans are only required if your flight will take you more than 50NM from land, or if the pilot in command requires an alerting service. But you can submit a VFR flight plan for any flight if you wish.
VFR flights for which a flight plan has been filed must maintain a listening watch on the appropriate frequency. If the pilot wishes to report positions the report should contain the following elements (as appropriate)

- Identification -Your call sign.
- Position As covered in "Local Flights"
- Time In minutes past the Hour
- Altitude As covered in "Local Flights"
- ETA At your destination or next landing point as appropriate.
- Route To next significant position.

SARWATCH. (Search and Rescue Watch)

Sarwatch is an option pilots may choose when requiring an alerting service.
Sarwatch is available for flights both within controlled and class G airspace.
To request Sarwatch the following details must be provided.

- Aircraft registration.
- Aircraft type.
- Route details including destination or standard plan identification.
- Persons on board.
- Nominated "Sartime" (The nominated time for search and rescue to be initiated if you do not arrive).
- Name and telephone contact details of the Pilot-in-Command.
- Name of aircraft owner or operator.

To request SARWATCH just radio the nearest ATC unit.

ULN TOWER, FOXTROT TANGO INDIA, REQUEST SARWATCH. ULN TOWER
The Controller will then ask you for the above details.
Submitting a Flight Plan or Requesting a Sarwatch might cost you a few dollars, but they are available for your safety so don't be frightened to use them.
If you realise that you will not arrive at your destination before or at your ETA, contact the nearest ATC unit and amend your Flight plan or Sartime.
REMEMBER!!!!! Both Flight plans and Sarwatch MUST be terminated, either by contacting an ATC unit by Radio or Telephone or if this is not possible ringing "The National Briefing Office" on 0800 626 756.
Failure to do this will cause a lot of people considerable annoyance and leave you with egg on your face which will be difficult to wash off.

EMERGENCY RADIO PROCEDURES

The radio is an invaluable tool when you are in trouble. Alerting others to your problem and position will save time and resources if a search is required. There are two Degrees of Emergency **MAYDAY,MAYDAY,** and **PAN,PAN,**

MAYDAY

This call should be transmitted three times This is the top priority call and has priority over all transmitted calls. It can be transmitted on any frequency but should be transmitted first to ; **the local ground station- such as CHCH CONTROL** or the local area frequency or 121.5MhZ- the Emergency frequency. You must know the frequency for these areas and write them down before you enter the zone. YOU WILL NOT HAVE TIME TO LOOK FOR FREQUENCIES WHEN AN EMERGENCY OCCURS!
A MAYDAY call can be issued for any emergency where life is threatened. This may be an engine failure, a structural failure, a medical problem with the pilot in charge or a fire on board. When a MAYDAY call is transmitted the pilot should give as much of the following information as possible;

- your call sign(papa-xray-india)
- location, height and heading
- nature of problem
- your intentions.

REMEMBER that the most important thing to do is concentrate on flying the aircraft. REMEMBER that if the emergency is reduced or cancelled tell the station you called.

PAN,PAN

This call PAN,PAN, should be transmitted three times. The call is used for non-life threatening situations where others should be alerted to a problem you have that may worsen. Calls should be made to; **the local ground station- such as CHCH CONTROL** or the local area frequency or 121.5MhZ- the Emergency frequency. Such problems could be ;

- You are lost and need assistance.
- non urgent aircraft problem such as non closing door or broken window.
- you see another craft in distress.
- you are making an urgent course change to get to a safer position.

While making an emergency transmission is very important ,it is also very important that you take measures to help searchers find you .You can help by;

- filing a flight plan, either with ATC, or on the notice board of your club, or by informing an associate of your plans.
- Carry a cell phone
- Carry an ELT(Emergency Locator Transmitter) These can be attached to the aircraft or:
- Be a hand held PLB (Personal Locator Beacon)

An ELT currently operates on 121.5 and 243MHz but soon all ELTs will have to operate on 406 MHz and 121.5 MHz. ELTs can be manually activated or automatically activated on impact. If accidentally activated you must switch it off and notify the nearest ATC station immediately. It you wish to test your ELT. Switch your radio to 121.5 and activate your ELT ONLY IN THE FIRST 5 MINUTES OF ANY HOUR AND ONLY FOR 3 CYCLES. This should only be carried out inside a hangar or other radio signal shielded area. You should hear the signal on your radio. Automatic activation of the ELT may result from a heavy landing . Always check it after any heavy landing.

EMERGENCY LOCATER TRANSMITTERS (ELTs)

With effect from 1 July 2008, **all microlight aircraft flying more than 10NM from the airfield must be fitted with a 406MHz ELT**. The ELT may be a unit permanently fitted to the aircraft, or a PLB carried by the pilot.

Digital 406 MHz technology is vastly superior to the old anologue 121.5 MHz system. A 406 signal can be picked up by a fleet of new satellites. Another important advantage of the 406 MHz beacon technology is that the 406 MHz beacon transmits a digital message containing the country code and a unique identity code for the beacon. The country code indicates the country where details of the beacon registration are held. This unique code can also identify the aircraft that the ELT is installed in, or in the case of a PLB the name and contact details of the person carrying the PLB. It is essential that the unique code entered in the ELT or PLB, together with the name and emergency contact details of the aircraft operator or owner is registered with the Rescue Coordination Centre of Mongolia (RCCMGL), and that any change in these details is also notified to RCCMGL.

- All ELTs transmit the emergency code on 406 MHz, as well as a beacon signal on 121.5 MHz. The 406 MHz signal is immediately received by satellite and routed to the national rescue coordination centre (RCCMGL for MGL coded ELTs). The RCCMGL knows immediately **WHO** is in trouble.
- Some ELTs include a GPS receiver, and also transmit the GPS coordinates on 406 MHz to the satellite. With these ELTs the RCCMGL knows immediately **WHERE** the aircraft is down.
- All ELTs transmit a beacon signal on 121.5 MHz. In the case of non-GPS ELTs, this beacon signal is used by satellites to locate the downed aircraft. This location process is less accurate than GPS, and can take up to 40 minutes.
- The 121.5 MHz beacon is also useful for checking for accidental beacon activation after each flight.

Operating an ELT

Whatever type of ELT your have, it is important you understand how to activate it. Read the manual on your ELT and be sure you know how.

- **ELTs installed in the aircraft** are normally automatically activated on impact. They can also be activated manually by either a remote switch on the panel, or an activation switch on the unit itself.
- **PLBs carried by the pilot** must be manually activated- usually by pulling a tab which unfurls the antenna and activates the beacon.

Checking an ELT activation

Just prior to shutdown after each flight, make a point of briefly scanning 121.5 MHz on your VHF radio in case your ELT has been activated by a hard landing. If so, switch the ELT off and advise the RCCMGL of the accidental activation.

Testing an ELT

An ELT may be tested for correct operation by manual activation **within the first 5 minutes of the hour**. The actual test method will depend on your particular model, but most involve pressing a TEST button with the results shown on a test indicator light. Be careful with this test, as during the test sequence the beacon will transmit on 121.5MHz. You may face an embarrassing telephone call and/or rescue bill. If in doubt- take it to an approved person for testing.

ELT maintenance

An ELT contains batteries which will deplete over time. Your ELT will require battery replacement every 2-3 years. Refer to your ELT manual or take it to an approved person for battery replacement. ELTs will require periodic maintenance checks by a appropriately qualified persons. The definitive detail of these requirements will be notified by CAA before the effective date in the form of an AC (Advisory Circular).

OTHER THINGS YOU SHOULD KNOW.

The above text has been written specifically for the microlight pilot who usually flies outside controlled airspace. The following text is intended to highlight the additional knowledge required to fly in controlled airspace.

Transponders

Transponders allow the positive identification of aircraft by a system where your aircraft is sent a signal that prompts your transponder to transmit a ‘Squawk’ Code which establishes your position, altitude, heading, and speed. At the beginning of each flight, individual aircraft are instructed to dial in a code which will identify them for that flight.
The Transponder has a multi-position switch labeled OFF, SBY , ON , ALT , TST.

- **OFF-** Transponder is OFF
- **SBY-** STANDBY mode, the unit is on but will not transmit information if interrogated
- **ON-** Transponder will send the dialed up 4 digit code data only to ground station. Mode A.
- **ALT-** Transponder will send code data and altitude data to ground station. Mode C.
- **TST-** Selects a self test mode.

The **IDENT** button will cause you image on the radar screen to flash. It must only be used when instructed by ATC.
Certain areas of controlled airspace are classed as "Transponder Mandatory Airspace". These areas are depicted on the charts by the Category and Class being in reverse print. Refer to the Planning Manual, RAC section. Before entering Transponder Mandatory Airspace you may be asked to dial up a specific code frequency by ATS. The action of dialing a requested frequency is called ‘SQUAWKING’.
Unless instructed otherwise by an ATS unit, all transponder equipped aircraft in Transponder Mandatory airspace must set a standard code as indicated below.

- Taxiing and circuit flying Select "Stand By"
- Powered aircraft in General Aviation Areas. Select 1400
- Fixed wing aircraft Select 1200.

Emergency situations can be indicated to ATS by dialing your transponder to certain codes.

- Code 7700 To indicate a state of emergency other than the following.
- Code 7600 To indicate communication failure.
- Code 7500 To indicate unlawful interference. (Hijack etc)

When dialing in a code into your transponder you MUST remember to switch to "Stand By" mode if passing through the 7000 series otherwise your transponder will lock on to 7500 and at your next stop you could get your tyres shot out. Also, do not operate the ‘IDENT’ feature unless instructed by ATC.
It is good practice to keep your transponder on in Mode C even when outside controlled or Transponder Mandatory airspace. This is because many commercial aircraft are fitted with TCAS systems which alert them to transponder equipped aircraft in the vicinity. This is good aviation practice, and helps with safety and separation.

Radio Frequencies

VHF transmission is relatively short range and is dependent on line of site. HF (High Frequency 3mHz -30Mhz) has a longer range as signals can 'bounce' off the surface of the Ionosphere and be reflected over a long range, however, bouncing does reduce signal strength and clarity. HF radios are a physically separate radio and are not used in microlights.

Information

Information on airfield communications is defined in the AIP (Aeronautical Information Publication) This describes the area frequency, whether the station is manned or has radar and what approach and departure procedures are to be followed.

AFIS

Aerodrome Flight Information Service is a service given by a field that is attended but is uncontrolled. If you fly to or in the vicinity of a field with this you must report to it. Your AIP GEN 3.3-3.4 will give details. At the time of writing the last AFIS at Milford has closed.
You must become familiar with your AIP and it's use for any flights away from your home base.

UNICOM

Universal Communication (UNICOM) Services are at time of writing not used in Mongolia.
They are not an Air Traffic Service. Information provided may include, current aerodrome information and conditions, basic weather and met reports. Aerodrome and Weather Information Broadcasts (AWIB) may also be provided in the future.

Loss of Radio

If you lose the use of your radio while flying VFR in uncontrolled airspace it may not be a great problem, but if it is lost in controlled airspace ATC may interpret this as a problem with your craft and instigate emergency procedures. If your radio is faulty and you are in controlled airspace you must keep away from busy areas, divert to the nearest landing point, clear of controlled airspace and inform ATC as soon as possible. If you have a cell phone, use it. Remember that you will be on radar as well and if you disappear from that ATC will be convinced you have a problem and call in emergency services. Make yourself visible, squawk 7600 if you have a transponder.

Communication Problems

If you think that your microphone is unservicable but you can receive there are approved ways of communication with another station. When you activate your transmit button you occupy the carrier frequency(ie 119.2MHz)and the base station knows someone is trying to transmit. If ATC suspects a problem they will ask you to activate your transmit button three times and then ask questions that have 'yes'/'no' answers. You respond by-

Answer	**Action**
YES or AFFIRMATIVE	activate button once
NO	activate button twice
SAY AGAIN	activate button three times
AT NOMINATED POSITION	activate button four times

Light Signals

Where the pilot does not have radio communication and wishes to operate at an attended aerodrome he may receive light signals as follows:

Light Signal	**Meaning in Flight**	**Meaning on Ground**
Steady Green	Cleared to Land	Cleared to take off
Flashing Green	Return for Landing	Cleared to taxi
Steady Red	Give way to other aircraft and continue circling	|Stop
Flashing Red	Aerodrome unsafe do not land	Move clear of landing area immediately
Alternate Red and Green Flashes	Danger, be on the alert	Danger, be on the alert
Flashing White	Land at this aerodrome and proceed to the apron	Return to the start point on the aerodrome
Red Flare	Do not land for the time being	

Responsibilities

Some basic responsibilities you have as Pilot in Command.

- You as Pilot in Command are responsible for all radio transmissions from the aircraft.
- It is your responsibility to ensure that you can operate correctly the equipment in your aircraft or any other aircraft in which you are Pilot in Command.
- It is your responsibility to ensure the radio equipment is in good working order.
- You must maintain a listening watch from the time you taxi to the runway to the time you come to a stop after a flight.
- It is your responsibility to ensure you are on the correct frequency for the area you are flying in. You must change frequencies as required by the FISCOM areas designated in your AIPMGL.
- You must limit your radio calls to information pertinent to your flight only.
- You must not divulge the content of any radio message to a third party unless authorized to do so by a CAA authorized third party.

Exam questions can be found in the exam section

11. Human factors

HEALTH

Pilots are supposed to be a pretty healthy lot, but even the finest human specimens have off days.
On these days, the safe pilot stays on the ground. Even though you may be an experienced pilot, flying with any sort of impairment must be avoided. Piloting requires rapid and frequent decision making and this means one must be feeling fit and well rested.
It is up to the individual to assess one's fitness to fly on any given day.
Do not fly if

- you are **tired or feel weary**.
- you have a **hangover**.
- you are **drunk or drugged**.
- you are on any **medication** (consult your doctor).
- you have a **stomach upset or headache**.
- you have been to a **dentist and had a local anaesthetic**.
- you have a **lot on your mind**.
- you have a **cold, cough or flu** etc.
- you are **recovering from an illness**.
- you have had a **concussion or accident causing shock** (consult your doctor).

If there is the slightest doubt about your fitness, forget flying until you are better.
When on any medication, see your doctor and ask how you might be affected, and when you might be fit to fly again.

Introduction

Human Factors is the term which broadly encompasses the study of human performance and limitations pertaining to operating an aircraft.
We have not evolved with the ability to fly. As a species we lack the physique, the physiology and a number of perception skills which are inherent in birds and other creatures which have evolved to fly. As aircraft have improved in reliability and ease of operation, the pilot has become an increasingly important component in aircraft accidents. Sadly, recent research has indicated that some 75% of aircraft accidents have significant human causal effect. Understanding our own human limitations is as important as knowing the limitations of the aircraft we fly.
Man evolved and adapted to a world which provides moderate temperatures, sea level atmosphere, a gravitational force of 1, good visual references and moderate speeds. If any of those conditions are disturbed the human being is placed in a potentially very hostile environment.
In the aviation environment we have to deal with a three dimensional world which is dynamic and at times requires a lot of ourselves as individuals to manage. That we can do this with comparative ease is not only due to aeroplanes which are relatively simple to operate, not only due to the sophistication of instruments and electronics, but also to the most important part of the equation - ourselves .
You have been, or are about to, be well trained in how to fly aeroplanes, and how to operate in the sky. And that learning will be on going for as long as you fly. Human Factors is about making sure that you are aware of your own physical and mental limits and how to manage them.
As pilots we require our machines to be in top order, our instruments to be reliable and accurate and such is the technology this is nearly always so. We also need to be in good order ourselves, and to understand some of the stresses (and how to deal with them) that are unique to going out and *committing aviation*.
We all have regular medicals, but what is presented to the clinician is only a snapshot of ourselves, and for most of us in the *micro-lighting* world our medical is a declaration with a general examination. All doctors will do more than that if you ask them. Get yourself checked out when you do your next medical. It's a comfortable feeling walking out of the surgery knowing all is well, and this is the common experience.

In the meantime, between medicals, what can we do to *pre-flight* the most important component **-** you? As a simple starter, before you pre-flight the aeroplane, run through the following check on yourself. Its simply called **I'MSAFE**: do it each time you fly. Be honest about it **-**

- **ILLNESS**. Don't fly when you're ill. Even if its only a cold. All illnesses have the potential to cause visual and sense of balance problems. And give yourself suitable time to recover from an illness. Make sure you're fit. **'Do I have any symptoms?**'
- **MEDICATION**. Very few medications, including *over the counter* medications are designed with the pilot in mind. All medications have side-effects with drowsiness and suppression of primary senses being common. If your in doubt check it out. Your doctor, practice nurse, or chemist can tell you. And don't fly until you do. **'Have I been taking prescription or over the counter drugs?**'
- **STRESS**. Its said and its very true that some stress in life is a good thing, but we know that there is an optimum amount, and we all know what its like if we exceed those very individual limits. Don't think that flying is a good stress-reliever **-** it is supposed to be relaxing, but you need to be able to operate if things become stressful in the cockpit, so, if its that bad, work it out somewhere else rather than in the air. **'Am I under pressure from the job? Do I have money, health or family problems?**'
- **ALCOHOL or DRUGS**. Both are especially bad news for judgement, decision making and balance. . Don't fly with a hangover - and if you smoke dope, choose another hobby. **'Have I been drinking with 8 hours? Within 24 hours?**'
- **FATIGUE**. All of us are aware of our degraded performance when we are tired. Flying can be very demanding. Make sure you are well rested. **'Am I tired or not adequately rested?**'
- **EATING**. Have a good breakfast before you fly. If your away on a x-country, take a bite to eat and take sufficient water. Altitude increases the rate of dehydration. And dehydration will impair judgement. **'Have I eaten enough of the proper foods to keep adequately nourished for the entire flight?**'

We will not eradicate human error, but we can and should work towards managing it and reducing its negative consequences: Graham Wardell, CFI, Auckland Aero Club .

Normal human functions of vision, hearing, balance and orientation, respiration and mental capacity can all be adversely effected when we fly. In addition, we must cope with *G* forces, pressure changes, temperature changes, and humidity changes. Adverse medical factors such as alcohol, drugs, dehydration, hypoxia, disease and illness will also come into play.

The following explanations and strategies are discussed because when they are taken into account, they will enhance the pleasure we all get from going out to the airfield and safely committing aviation.

Vision

Good vision, both inside and outside the cockpit is obviously essential for safe flight. It tells us where we are going, where we have been and what is sharing our immediate airspace with us. It also plays a major role in balance and orientation. In fact our eyes provide about 80% of the orientation information received by the brain. Visual function requires about 30% of our oxygen requirements which may explain why this mechanism is so sensitive to hypoxia (lack of oxygen).

There are factors adversely affecting vision:

Blind spot - Small nerves behind the retina carry light stimulated nerve signals to the brain via the optic nerve, an area at the stalk of the eye where there are no light receptors. Any light falling on this area does not reach the visual centre of the brain. People generally are not aware of their *blind spot*, as the brain tends to fill in what it thinks should be there.

Time lag - The time lag in the visual process is very important when considering reaction times. *Look out* for pilots is not only a process of looking and seeing, but also a process of recognising, deciding and responding. Even in ideal conditions a time lag of up to 7 seconds may elapse between seeing and responding. How far can two converging aircraft travel in this time? The following two tables may provide food for thought.

TIME LAG BETWEEN LOOKING AND RESPONDING			
Phase	**Response**	**Time**	**Total time**
Looking	Is there something out there?	0.2 seconds	0.2 seconds
Seeing	Yes indeed there is!	0.3 seconds	0.5 seconds
Recognising	Its another aircraft!!	1.0 seconds	1.5 seconds
Evaluating	And its coming this way!!!	3.0 seconds	4.5 seconds
Responding	Maneuvering to avoid danger	3.0 seconds	7.5 seconds

CLOSURE RATES
At 120 knots closure they will travel towards each other 432 meters in 7 seconds
At 150 knots closure they will travel towards each other 540 meters in 7 seconds
At 180 knots closure they will travel towards each other 648 meters in 7 seconds

Scanning - Because of the way the human eye is structured, the area of acute visual perception for most of us is about a 20 degree cone around the retina, giving us a 20 degree arc of accurate vision. Because it takes about 1.5 seconds under normal circumstances for the process of looking, seeing and recognising to occur (glare and contrast factors can delay this process even further) we need to develop a scan that maximises our ability to keep a good lookout. Hence the development of the *20 degrees* **-** *2 seconds* rule. Divide the sky off into 20 degree segments and scan each for at least 2 seconds. You can apply the same rule to scan back in the cockpit.

If the view outside the cockpit is relatively unbroken by distinctive features, a type of *short-sightedness* can occur. This may happen when flying in hazy conditions, or over a smooth sea for example. This *short***-***sightedness* occurs because the eyes take up a relaxed state which causes them to be focused at a point 3 to 4 meters distance. You may think you are keeping a good lookout, but you are in fact focusing just outside the cockpit.! *Empty visual field blindness* can be overcome by periodically focusing on some distant feature, which will exercise the eye.

Effect of hypoxia (oxygen deprivation) on vision - As discussed the visual system requires about 30% of our oxygen requirements and is there fore extremely susceptible to oxygen deprivation . Sharpness of vision, colour perception, peripheral vision will all be affected.

The effect of *g* forces on vision - Pulling (positive) g will reduce blood flow and therefore oxygen supply to the brain. The pilot may notice loss of colour perception, loss of peripheral vision, blurring, and total loss of vision (*black out*). *Black out* is not the same as unconsciousness, but unconsciousness may quickly follow if the *g* force is maintained.

The effect of fatigue on vision - Our eyes are largely muscles which can be affected by fatigue. Although focusing is largely an automatic function, it still requires a certain amount of energy and the eyes can be among the first bodily function to become tired if the body is tired. We are all familiar with the need to rub, close and rest the eyes when we are tired. When we are tired, vision clearly suffers.

Canopies and vision - Think of your canopy as a visual aid **-** and treat it as if it were a good pair of sunglasses. Clean canopies are a delight, dirty or scratched ones are not. Clean the canopy inside and out before each flight with a non-abrasive cleaner and a soft lint free cloth. Wiping needs to be done vertically rather then horizontally.

Visual illusions - The visual system is not always accurate and can play *tricks* which can fool the unwary. We have already discussed the *blind spot*. A pilot in a cockpit with window and door frames needs to be aware that there is a tendency for the brain to *fill in* these gaps in vision without the pilot being aware of what is happening. We could be seeing a continuously empty sky, with that door frame hiding an approaching aircraft if it is in the pilots blind spot. Use the *degrees* - *2 seconds rule*.

The brain is not always good at making visual comparisons, especially in conditions of poor viability, distracting line features and lack of familiar surrounding objects and features. A classic example is when a pilot familiar with trees of a certain height at his home field travels to a different area where the trees are smaller. The pilot will fly lower if he is judging airfield height by trees alone. Fatal accidents have been caused by this.

RESPIRATION

Respiration is the process of molecular exchange of oxygen and carbon dioxide within the body's tissues, from the lungs to cellular oxidation processes. The process is usually involuntary.

In the lungs are minute air sacs (about 300 million) called alveoli. The walls of the alveoli are very thin and semi-permeable. There is a pressure gradient across them which allows oxygen to pass into the bloodstream via very fine capillaries, and carbon dioxide to come out of solution in the blood and into the alveoli where it is then exhaled. The oxygen is able to combine with haemoglobin in the blood and is then transported to every cell in the body. The air we breath is a combination of gases comprising 78% nitrogen, 21% oxygen and 1% other gases . Nitrogen plays no part in respiration. Respiration depends entirely on the amount of available oxygen.

The ratio of oxygen to other gases remains constant at the altitudes we fly but pressure reduces with altitude. It is a general rule that total pressure of air has halved by 18000 feet and halved again by 34000 feet. The actual amount of oxygen available reduces with altitude in the same proportion as the other gases.

Dalton's Law of Partial Pressures states that the total pressure of a mixture of gases is equal to the sum of the partial pressures of the individual gases.

So, how much oxygen do we need? The *standard atmosphere* assumes a sea-level pressure of 1013.25 millibars, or 14.7 psi, or 760 mm of mercury (Hg). The partial pressure of oxygen at sea-level is approximately 150mmHg. Once inhaled, this partial pressure of oxygen is further reduced because of the continual presence of CO2 and water vapour in the lungs. Thus, 102 mm Hg is the required partial pressure of oxygen in the lungs for normal functioning, and any major reduction of this pressure will have adverse consequences.

As we ascend in the atmosphere, the quantity and pressure of oxygen available is reduced below the required 102mm Hg. Adverse effects of this reduction are not especially noticeable below 8000 feet, but can become critical above 10000 feet. Above 10000 feet we must have supplemental oxygen available.

The legal requirement is as follows : **During any time an aircraft is being operated between 10000 feet and 13000 feet AMSL for a period of more than 30 minutes, or above 13000 feet AMSL, each crew member and each passenger must use supplemental oxygen. Any passengers carried when supplemental oxygen is required must have been briefed on the normal and emergency use of the oxygen equipment used.** The Civil Aviation Rules prescribe detailed requirements for the type of oxygen and equipment to be used, and for its use.

General symptoms of hypoxia include:

- euphoria
- target fixation
- personality changes
- loss of judgement
- 'fuzziness'
- amnesia
- lethargy
- confusion
- heat/cold sensitivity
- cyanosis (blueing of extremities)
- unconsciousness
- death

Visual symptoms of hypoxia include:

- decrease in colour perception
- decrease in peripheral awareness
- decrease in visual acuity.

Neuro Muscular symptoms of hypoxia include:

- clumsiness
- fine tremor
- speech slurring
- slow movements

There are two very important and rather sobering aspects of hypoxia that should make pilots especially wary: The insidious effects of hypoxia and the time of useful consciousness. Although its not usual for micro lights to fly much above 10000 feet, it is reported that it is increasingly common for them to do so. The following table may be of interest:

Time of useful consciousness		
Altitude (feet)	**Sitting**	**Moderate Activity**
18000	20-30 minutes	10-15 minutes
21000	10 minutes	5 minutes
25000	3 minutes	2 minutes
30000	1.25 minutes	45 seconds

Factors influencing onset, intensity and tolerance of hypoxia - Altitude attained, rate of ascent, time at altitude, physical activity, ambient temp., illness, fatigue, drugs/alcohol, smoking, stress/workload level of fitness.

Action in the event of suspecting hypoxia -

1. Go on to oxygen and select full flow (beware the Oxygen Paradox - next)
2. Check oxygen system for leaks, kinks and contents.
3. Reduce power, extend flaps and trim aircraft for maximum descent rate.
4. Get below 10000 feet
5. Report what is happening.
6. Unless absolutely sure why the problem occurred, return and land.
7. In returning, be cautious ; you will be fatigued by the incident so don't rush and DO listen to advice from the ground.

If you suspect hypoxia in a pilot in an other aircraft, get them to do the above: talk slowly - they may not be aware they are hypoxic and reluctant to listen - if they can hear at all. And watch from a safe distance - they will have visual problems!

Oxygen Paradox - This is a temporary worsening of symptoms when oxygen is restored to someone who is hypoxic. It is caused by a reflex which constricts momentarily the arteries to the brain. The danger is that you may feel worse momentarily when you first go on oxygen, you then suspect it isn't working and turn it off!!

Common causes of Oxygen deficiency include not using supplemental oxygen when its required, failure to turn on the system, poor fitting masks, mask removal, system failure. If your going to fly at these kinds of altitudes, **PRE-FLIGHT THE OXYGEN SYSTEM JUST LIKE YOU WOULD THE AIRCRAFT!!**

Hyperventilation is a condition where an abnormal increase in the breathing rate results in an excess loss of CO_2 which in turn raises the alkalinity of the blood. This pH change causes a number of adverse effects :

- Rapid pulse
- Feelings of unreality
- dizziness or faintness
- tightness of the chest
- Numbness or tingling in the hands, feet and around the mouth
- increased anxiety
- clumsiness and tremors
- fainting in severe cases

- feelings of shortness of breath

Causes of hyperventilation include

- excessive worry or anxiety
- pain
- loud noise
- vibration
- heat
- motion sickness
- hypoxia
- *G* loading

Treatment of hyperventilation -

- Encourage deep and slow breathing (12 - 16 breaths per minute).
- Use oxygen if available
- Be reassuring
- Re-breathing (cup hands or use a bag)
- Do not hold your breath!!

Remember, hyperventilation may be a symptom of hypoxia, but this is unlikely at lower altitudes (below 10000 feet). A person who is hyperventilating will not be harmed by breathing 100% oxygen whereas telling a person who is hypoxic to slow their breathing could kill them.

PRESSURE CHANGES

As we climb and gain altitude, atmospheric pressure continuously decreases. According to Boyle's Law, at a constant temperature if the pressure of a gas is halved, its volume will double. The opposite is so on descent. There are several areas in the body where gas is trapped, for example the stomach and the gut, the middle ear, the sinuses, and the teeth. As these gases expand and contract with altitude changes, they can cause some issues.

Stomach and gut - These areas seldom cause problems as there is ample room for the gases to expand. However, some may feel discomfort. The rule here is simple -**F**lex, **A**irate, **R**elax, **T**ell. And then smile!

Middle ear - Gas trapped in this area usually escapes through the Eustachian tubes (tubes which connect between the middle ear and the throat, which enable the pressure in the middle ear to be equalised). Those tubes could well be blocked if you have a cold or the flu. Ear pain on descent is common, uncomfortable and can have serious implications. Clear the Eustachian tubes by swallowing, moving your jaw or using the **Valsalva Manoeuvre** (pinch the nose, tilt the head back slightly and momentarily pressurise the throat by forcing air up from the lungs, causing the ears to *pop*). Sudden descents with blocked Eustachian tubes can cause damaged eardrums, permanent hearing impairment and inner ear infections.

Sinuses - these can cause pain on ascent if the sinuses are blocked. Normal rates of ascent shouldn't cause problems. Flying with a cold is not recommended because of the difficulty you will have clearing your ears and sinuses.

Teeth - Tiny pockets of air under fillings etc will expand and may even cause fillings to dislodge. Pain will normally be relieved on landing. Take some pain relief and go visit your dentist.

Nitrogen and the *bends*

As we have already discussed, nitrogen makes up about 80% of the earths atmosphere. Although not required for respiration, it may be found in solution in the bloodstream as well as organs. Normally these dissolved gases don’t pose a problem for pilots below 10,000 ft. Prolonged high altitude flight however can allow the dissolved nitrogen to come out of solution, form small bubbles which are then free to move about the body. A serious attack can cause serious and permanent problems.

Symptoms include:

- Joint pain
- Itchiness
- Numbness
- Tingling
- Paralysis of parts of the body
- Poor co-ordination and movement
- Mental confusion
- Visual disorders
- Inner ear problems
- Shortness of breath
- Tight or painful chest
- Painful coughing
- Unconsciousness

So why are we discussing an issue which is well known in the scuba diving community? Very few of us fly above 10, 000 ft. But some of us fly as well as dive, and pilots flying too soon after a dive are especially susceptible. A good rule is to allow at least 24 hours between the last dive and flying, and if your dive has exceeded 35 meters depth, 48 hours would be wise. The *bends* is a serious medical emergency and urgent compression in a recompression chamber is imperative. And if you happen to be flying the patient to medical assistance, do not fly above 500ft AMSL. Doing so will SERIOUSLY aggravate the condition.

BALANCE AND ORIENTATION

Orientation is essentially the ability to know which way is up, and where we are positioned relative to the sky and the ground. This a largely automatic process which we take for granted. At least 80% of the orientation information is provided by vision with the rest provided by movement sensors in the body. In conditions of 1*g*, at slow speeds , we can easily confirm our position or orientation by visual reference.

In flying however, things can be quite different. We may have poor visual references. We may be trying to cope with a wide range of speeds and accelerations. Things can and do go *awry*.

The visual system - The importance of the visual system cannot be over-emphasised. It is as important in flying as it is on the ground. As pilots, we are taught from our first lesson to fly an aircraft by relating its attitude relative to the horizon.

The balance organs - These comprise of two main organs: the Semicircular Canals and the Otolith Organs. Both are contained in the inner ear.

The semicircular canals are three fluid filled tubes mounted at right angles to one another so as to sense accelerations in 3 planes of movement. Once the acceleration has stopped they will cease to sense it. A steady state turn may therefore not be detected. Although sensitive, the canals have a threshold to cut out minor accelerations. Problems can occur where these sub-threshold accelerations are suddenly detected or if they are misinterpreted. An extreme example might be where a pilot in cloud or at night believes himself to be in a dive with wings level, but in fact the aircraft is in a dive with bank. The turn is completely undetected, and if the pilot attempts to pull out of the dive with elevator only, matters are made worse. This particular situation has sadly killed many pilots - John Kennedy Jnr being amongst them.

The Otolith Organs sense both *tilt* and longitudinal acceleration. They can give erroneous information and in particular they can misinterpret a forwards acceleration as a steep climb with severe consequences if a pilot attempts to correct a steep climb that is not there, near the ground.

We also have a nervous system which detects pressure on the body, stretch and body position. An example is pressure on the buttocks when sitting. Remember however that the body without visual reference cannot distinguish between a +3G loop and a +3g turn.

Persons on the ground will not often become disorientated as all 3 balance and orientation systems tend to work together to confirm the information that each is passing to the brain. In the air however there is a high potential for confusing and conflicting information to be passed to the brain and if we try to rely on *seat of the pants* or *the feel of things*# without proper training, the results can be catastrophic.

- Stay in visual conditions unless you can fly on instruments.
- You will have less than 180 seconds before you will loose control.
- Micro light Aircraft are not permitted to fly either at night or in cloud under any circumstances.
- This is why.

There are two other manifestations of disorientation **- flicker vertigo and motion sickness** distracting and if prolonged can cause a person to feel dizzy and quite unwell. Re-position the aircraft to avoid the effect.

Motion Sickness is caused by prolonged (also sudden) unaccustomed motion of the body which upsets the orientation system. Motion sickness can be aggravated by anxiety and low cockpit activity. And it tends to be more common among passengers and trainee pilots than amongst the experienced. For trainee pilots, gain air experience as soon as possible. This will reduce both the anxiety while increasing confidence levels. Keep fit, rest well and eat sensibly before flying. Instructors: allow the student to do as much of the flying as possible - this will do much to reduce the chances of motion sickness occurring

Passengers should be given warning of any manoeuvres and unnecessary manoeuvres should be avoided. And if it happens, might I suggest that bi-carbonate of soda in a bucket of water is probably as effective as any of the commercial cleaners. Stow a suitable disposable bag in the cockpit for those less than smooth days.

TEMPERATURE AND CLIMATIC CONSIDERATIONS

Exposure to high environmental temperatures is clearly the most common cause of overheating or heat stress. Breathing dry air, or oxygen, may exacerbate this along with wind, exertion, dehydration and fatigue. The prevention of heat stress and its related condition, dehydration, is particularly important for pilots especially pilots involved in long cross-country flights.

Heatstroke occurs when the body's internal temperature control system becomes stressed. The body responds by increasing blood flow to the skin, which then uses sweat glands to produce moisture which cools the body by a process of evaporation. In extreme conditions of temperature and/or humidity, the body may have difficulty dissipating enough heat by these methods, and internal temperatures can rise to dangerous levels.

Mild episodes may produce little more than a headache, cramps or a rash. If allowed to continue, or to worsen, hallucinations and collapse may result. In the case of severe dehydration, the body may stop sweating in which case you are also dealing with a serious medical emergency which requires immediate medical attention.

Dehydration is related to heat stress and may share many of the same symptoms. Essentially, you need to ingest between 250-300 mls/hr simply to cover fluids lost by respiration. 5-600 mls/hr is recommended, especially on hot days. Carry water in the aeroplane with you when you are going on a cross country. Drink plenty of fluids and avoid diuretics (fluids which make you pee) such as coffee.

All the aircraft in my club have transparencies in their roofs (one doesn't actually have a roof). Wear suitable head wear. Wear loose fitting clothing which will allow some air to circulate around your body.

Ensure the body is well watered and fit. And for those of you who do long duration flights, remember that there have been *emergency* landings made in such haste that bladders have ruptured and major medical emergencies have happened. Carry a suitable receptacle. What goes in does go out. Lets all ensure its via the normal route.

Symptoms of heat stress:

- Heat rash
- Muscle cramps
- Headache
- Nausea (and vomiting)
- Dryness of mouth, eyes and nose
- Poor coordination
- Poor concentration
- Drowsiness
- Weakness
- Lethargy
- Slurred speech
- Confusion
- Hallucination

Overcooling This is just as much as a problem as overheating. The direct cause is low environmental temperatures. Contributing factors include:

- Insufficient correct clothing (greatest heat lose occurs through the head)
- Hypoxia
- Fatigue
- Food - not enough or the wrong kind
- Anxiety
- Injury
- Recent illness
- Wind
- Wet clothing

Symptoms include: uncontrolled shivering, tiredness, clumsiness, irrational behaviour, lack of energy etc. For those of us in the Trike/open cockpit world, be sensible. The wind chill factor is extreme. Remember that cases of frostbite requiring amputations have been recorded following open cockpit flights.

MENTAL AND PSYCHOLOGICAL FACTORS

It is very difficult to define the *ideal* pilot personality. Sadly, its far easier to define what makes a bad pilot, as these are the folk who usually end up in the accident statistics. Fortunately modern aviation psychological testing as applied by air forces is able to throw some light on the process, and give some rules of thumb, and these #rules# are as applicable to sport aviation clubs as they are to the military. Its important for each of us to understand the role that pilot personality can have in aviation safety practices

Reckless and erratic personalities generally do not make good pilots. *Bad* pilots are over-confident, slapdash, impulsive, careless, complacent, dogmatic, arrogant, inaccurate, and rough on aircraft/equipment. All *good* pilots should be alert for *bad* pilots, who will require close watching and special attention if they are to continue flying and become *good* pilots.

Good pilots, on the other hand display good airmanship at all times. Airmanship may be defined as the display of good common sense, good practice and high standards in the air. *Good pilots* not only have good flying skills, but also personality traits which if not innate, can be learned and developed. *Good pilots#* stay out of trouble. Generally, they do not have incidents or accidents which are a result of bad decision making or faulty decisions.

The aviation environment can be demanding physically and psychologically, and attitudes to safety, pilot personality, human learning mechanisms, human capacity and workload may all play a part in the safety equation.

Mental capacity

When a person is learning a new skill, mental workload is high and the brain may be working at nearly full capacity. Residual capacity for making decisions or handling new tasks and emergencies may be low. As an individual becomes more experienced (and tasks become more automated), residual mental capacity is increased, allowing more accuracy as well as better decision making.

Mental performance suffers when the brain becomes overloaded with information or activity. Interestingly, if mental activity is too low, mental performance also suffers.

Stress and Fatigue

Stress is defined as *the non-specific response of a human to any demand for change*. These demands can be real or imagined - the stress on the body is the same.

Some stress is not only normal but essential - our bodies are built for it, and it is a normal part of life. We tend to enjoy different levels of stimulation at different times and if a good balance is maintained, few individuals have problems with stress.

Many folk however struggle to maintain that balance and its important for us in sport aviation to understand the symptoms and signs of stress which take us beyond our normal levels and degrade our performance and therefore effect our safety.

The two main types of stressors are direct and indirect. **Direct stress** in our sport comes from the immediate task of flying the aircraft. It may arise from such things as weather, turbulence, mechanical issues, navigational issues , personal fitness (including fatigue, hypoxia, dehydration etc). **Indirect stress** usually relates to issues to do with ones own personal environment - families, relationships, finance etc.

As long as your abilities as a pilot are greater than the demands flying places on you, the less of a problem stress will be . But if demand exceeds abilities, the chances of an accident becomes quite high.

Responses to the stressed state include:

- Forgetting important tasks
- Becoming short tempered
- Noisy of uncharacteristic behaviour
- Substance abuse (including alcohol)
- Relationship problems
- Flying dangerously or unsafely

More direct symptoms while flying may include nervousness or shaking, sweating, anxiety, non-typical behaviour and hyperventilation. Prolonged acute stress can have long term medical consequences including peptic ulcers and cardio-vascular problems.

Coping with Stress.

The best ways of reducing stress and its effects are to:

- Keep physically fit and healthy
- Eat well
- Rest, relax and sleep well
- Know you capabilities and stay within them
- Think and plan ahead
- Get organised and prioritise and avoid procrastinating
- Seek assistance
- Understand stress and how it effects you! And then do something about it.

Fatigue can be defined as the accumulation of unresolved stress perhaps building up over a period of time. It is debilitating and a fatigued pilot will be unable to fly safely. The symptoms of fatigue are similar to being excessively stressed and can be difficult to recognise in ourselves until quite advanced. Don't take pride in your ability to *hack* it - all you are doing is placing yourself and others at unnecessary risk. Remember, fatigue cannot be resolved quickly. It will only be resolved by resolving the workload/stress issues and by getting adequate sleep and rest. Stress management techniques, time management, better prioritisation, improved physical fitness and better quality sleep will help. Do something about it - but not in the air.

Operational Pitfalls

An FAA analysis many accidents has identified of classic behavioural traps pilots can fall into. Those particularly pertinent to microlight flying include:

- **Peer Pressure** Poor decision making based on an emotional response to peers rather than evaluating a situation objectively.
- **Mind set** The inability to recognise and cope with changes in the situation different from those anticipated or planned.
- **Get-There-Itis** This tendency, common among pilots, clouds the vision and impairs judgement by causing a fixation on the original goal or destination with a total disregard for any alternative course of action.
- **Scud Running** Pushing the capabilities of the pilot and the aircraft to the limits by trying to maintain visual contact with the terrain while trying to avoid physical contact with it.
- **VFR into IMC** Continuing visual flight into instrument conditions often leads to spatial disorientation or collision with ground or obstacles. It is even more dangerous if the pilot is not instrument rated.
- **Getting Behind the Aircraft** Allowing events or the situation to control your actions rather than the other way round. Characterised by a constant state of surprise at what happens next.
- **Loss of Positional or Situational Awareness** Another case of getting behind the aircraft which results in not knowing where you are, an inability to recognise deteriorating circumstances, and/or the misjudgment of the rate of deterioration.
- **Flying Outside the Envelope** Unjustified reliance on the (usually mistaken) belief that aircraft's capability meets the demands imposed by the pilot's (usually overestimated) flying skills.
- **Neglect of Flight Planning, Pre-Flight, Checklists** Unjustified reliance on the pilot's short and long term memory, regular flying skills, repetitive and familiar routes, etc.

Hazardous attitudes that influence pilot decision making

- **Anti-authority-** The rules do not apply to me. Found in people who do not like others telling them what to do. They may be resentful of advice from others, and may regard rules, procedures and regulation as silly or unnecessary.
- **Impulsivity-** I must act now! The need to do something-anything-immediately. They do not stop to think, and select the best alternative. They do the first thing that comes to mind.
- **Invulnerability-** It won't happen to me. These people believe that accidents happen to others, and never really feel or believe that they nay be personally involved. These pilots are more likely to take chances and increase risk.
- **Macho-** I'll show you how good I am. Pilots with this attitude will try to prove themselves by taking risks to impress others.
- **Resignation-** I must stick to the plan, I can't change things. If your number is up- it's up. This pilot will leave the actions and decisions to others, and may go along with unreasonable requests just to be a *nice guy*.
- **Deference-** It must be OK if **you** say so. Typical in a student/instructor relationship or in group flying, where one senior pilot makes decisions based on his skill and experience, and others follow along into situations outside of their abilities.

- **Denial-** It is not as bad as it looks or they say. Based on belief or hope rather than hard facts.
- **Get-home-itis-** I have to get there! Often because of promises made to others for flights, appointments, etc. Also if no options have been thought out- no Plan B.

For each of these attitudes there is an antidote...

- **Anti-authority-** The rules **do** apply to me. Most are safety oriented and are safe minimums learned from the wisdom and experience of others.
- **Impulsivity-** Don't rush- take a few seconds or minutes to think the situation through . Do your planning, do your checks. Don't be pushed or hurried by others.
- **Invulnerability-** It can happen to me. I am not bullet-proof.
- **Macho-** I don't need to show off to impress others. **Professionalism** in aviation is what counts and lasts.
- **Resignation-** I **can** make a difference. I have the knowledge and training to make a difference. It is important to have a Plan B, and maybe a Plan C... and use them when necessary.
- **Deference-** Make and act on the decisions you are comfortable with. Make these clear to others. Fly within your competencies and skills as pilot-in-command.
- **Denial- If it looks bad- it probably is**. Do not downplay the significance of flight relevant information just because it conflicts with your goals or intentions.
- **Get-home-itis-** Do not get cornered by your commitments, those of others, or timelines that dictate that you **must** fly. This often leads to an early appointment- with death or disaster.

G FORCES

Our cardio-vascular system is designed to perform at its best at a *G* force of 1. It is quite a complex system and is particularly susceptible to changes in *G*.

In an aircraft which is *pulling G* (the gravity value is greater than 1), the blood in the pilots head tends to be forced downwards towards the stomach and the legs. This reduces the blood flow, and therefore the oxygen flow to the brain. Up to about 2.5 *G*, the body can compensate, although this may take several seconds. Beyond 2.5 *G* however, so much blood is being drained from the brain that the pilot will progressively experience loss of colour perception, loss of peripheral vision, vision blurring, total loss of vision and ultimately loss of consciousness. All of these functions will be restored however upon the restoration of conditions of 2.5 *G* or preferably less.

In negative *g* conditions, we are even less tolerant. We may suffer a type of congestion where its difficult for blood to flow back to the heart. Oxygen availability to the brain and eyes is just as compromised as if there was insufficient blood pressure. Pilots describe *red out* - a condition probably caused by pooling of blood around the eyelids.

Sustained negative *G* is difficult to achieve in a micro light, so we are not often confronted with this issue. Most aircraft are designed for much less negative *G* than positive *G*. Always comply with the operating limits of the aircraft you are flying.

ADVERSE MEDICAL FACTORS

Drugs and Alcohol

Operating any aircraft while under the influence of any mood, perception or performance altering drug will have a serious and damaging effect on any pilots performance. This effect may last for many hours after consumption and should never be underestimated. This not only includes opiates, cannabis, methamphetamines, and LSD but also alcohol.

While the primary effects of alcohol are well known, what is not generally well known is that even though blood alcohol levels may have returned to zero, most people are unaware that their performance can be seriously impaired by the less-known after effects such as nausea, headache and fatigue. Even low to moderate use can seriously jeopardise the safety of a flight the following morning.

Effects of alcohol

- Poor performance generally
- Disorientation

- Dehydration
- Increased susceptibility to *G* forces
- Increased susceptibility to hypoxia
- Increased susceptibility to the *bends*
- Interference with the temperature regulation of the body

Alcohol will seriously degrade a pilots performance. Even small amounts. A study once demonstrated that even after achieving a achieving a blood alcohol level of 0.01%, pilots flying a simulator had a procedural error rate of 68%.

The immediate effects of alcohol will impair sight, balance and *seat of the pants* feel. Alcohol literally dilutes the fluid in the Semi-Circular Canals, meaning that with any sudden head movement, dizziness and nausea are often experienced due to these fluids travelling further and faster than they would normally. This results in exaggerated signals being sent to the brain, which can be extremely disorientating on the ground, let alone in the air.

Associated with this is the **Coriolis phenomenon** which is a severe tumbling sensation bought on by moving the head out of the plane of rotation, simultaneously stimulating one set of semi-circular canals while deactivating another. Very modest amounts of alcohol can induce this effect . Both of these effects can persist in some individuals for several days after blood alcohol levels have returned to zero.

Nystagmus affects the visual system and can be described as a series of eye movements caused by stimulation of the semi-circular canals. Nystagmus can be induced by spin recovery manoeuvres, and amplified in severity and duration if there is alcohol in the system. Pilots suffering from Nystagmus find it extremely difficult to focus either on the instrument panel or on the world outside. The disorientation is very marked and can quickly lead to total loss of control of the aircraft.. Nystagmus can be demonstrated up to 11 hours following the intake of even modest amounts of alcohol.

The hangover

The hangover syndrome can last up to 48 hours depending on how much the individual has consumed. General feelings of ill-health including headache, nausea, gastrointestinal disturbances etc will impair mental ability and seriously degrade your performance as a pilot.

Alcohol related fatigue

Alcohol is widely used as an aid to sleep. The problem with this is that it interferes with normal sleep patterns and provides poor quality sleep (either lack of, or no REM sleep). This results in feelings of tiredness and impaired concentration. A *nightcap* before retiring may cause increased tiredness the next morning.

The news is not all bad however. The body metabolises alcohol quite quickly (at the rate of 1 standard drink per hour) so enjoy alcohol consumed with your evening meal - just allow time for your blood alcohol level to drop. The ideal target is zero at lights out.

Alcohol has many side-effects including dehydration, which will allow the excessive excretion of electrolytes, minerals and salts. It will also reduce *G* force tolerance partly by vasodilation as well as the dehydrating effect which decreases blood volume. Alcohol is also known to impair the metabolism and utilisation of oxygen increasing your vulnerability to hypoxia.

Alcohol has a number of persistent effects that can negatively impact on safety in flight. There are significant problems flying during the *hangover phase*, and even flying the next morning after a few drinks may not be the wisest option. Adherence to a simple *bottle to throttle* rule does not guarantee maximum performance in the air. In some cases for some individuals this may mean not flying at all the morning after the night before.

'"CAA rules state:

- No operating an aircraft if your capacity may be impaired by the effects of drugs and/or alcohol.
- No passenger who is under the influence of drugs and/or alcohol is to be carried."'

Minor Illnesses

As stated, it is not recommended to fly with either a cold or the flu. Hay fever similarly will cause congestion, although you can use steroidal nasal sprays to help clear the sinuses (don't use anti-histamine pills - they will make you drowsy and inattentive - despite the assurances of the manufacturers).

Where a pilot has had a major illness, accident or operation which necessitates recovery in hospital and at home, its clear that the person should take a rest from flying until recovery and good health are regained.

What is not quite so clear is what to do when the illness has been of a less serious nature eg colds, influenza, bronchitis, headache, menstrual problems, diarrhea etc. Use common sense. Remember take-offs are optional, landings aren't.

There may be occasions where the day starts well but we get tired or unwell. This will undermine your performance and you won't learn when you're like this. Speak up if you are dual - your instructor will take your mind off it while returning to land. Carry an air sickness bag just in case and remember - many have *been there and done that*, so don't be embarrassed.

Syllabus for the UK PPL(G)

2009 Edition
Rev C (2014)

Recognised by the UK Civil Aviation Authority

Nothing in this syllabus supersedes any legislation, rules, regulations or procedures contained in any operational document issued by Her Majesty's Stationery Office, the Civil Aviation Authority, the manufacturers of aircraft, engines and systems, or by the operators of aircraft throughout the world.

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Changes from Rev A

Page 39: Advanced landings. Precision landing distance changed from 10 metres to 25 metres with power and from 10 metres to 100 metres without power

Briefing bullet points in many exercises updated

Changes from Rev B

Page 3 : Credit of hours of PPL(A) and PPL(H) changed to 15. References to LASORS replaced with references to Standards Document 44. Exams valid for 24 months.

Page 6 : Ex 6e title changed to read Vertical Descents

Page 16 : Added the specific flying objective to turn onto a heading

Page 22 : Remove the specific flying objectives to prerotate whilst taxiing and backtracking with the stick back

Page 23 : Added the specific flying objective to take off whilst emulating poor performance characteristics. Added the specific flying objective to abort take offs

Page 32 : Remove the unusual attitude to recover from a steep nose down attitude without power. Added the unusual attitudes of recovery from a high speed spiral descent, added a zero airspeed rotation to the right when there is loss of rudder authority, added the brief to discuss a tail slide.

Page 39 : The precision for a powered approach is now -0/+100 metres. The precision for a simulated power failure to the runway is now +/-100 metres. The engine to be reduced to idle from above 500ft AGL.

Page 40 : Remove the specific flying objective of a slow speed hover taxi at a few feet above the runway surface

Page 42 : Replaced zero airspeed descents to vertical descents and ensuring positive airflow is maintained at all times. Clarified the specific objective to recover with power has the aim to recover with the minimum height loss and the specific objective to recover without power has the aim to establish and maintain a safe flying speed for landing – power is only applied after the exercise is complete

Page 50 : Emergency field landing, removed the specific flying objective to determine the best range speed (this is not really an objective) and added the specific flying objective to include a restart procedure and (practice) MAYDAY call.

Introduction

The PPL(G) syllabus (2009 edition) is a statement of the scope of the training required for a student to apply for a licence to fly Gyros in the UK.

The syllabus is split into 2 parts:

- Part 1 contains the flying elements of the training
- Part 2 contains the theoretical elements of the training.

The purpose of this syllabus is to provide a consistent standard of training for all student pilots throughout the UK and to give a clear method of recording progress.

This syllabus replaces the 1998 revision. The scope of the training has not changed significantly, what this edition provides is a greater clarity into the standards expected of a student at each stage of the training. It also reflects the change in legislation that a student must complete a 2-seat training course, to the standard of being able to fly solo, before being allowed to fly in a single seat aircraft.

Each part of this syllabus has been subdivided into elements. These elements are designed to flow in a logical order and are at a suitable level of details to make it easy for a student and an instructor to record progress.

The CAA will issue the student with a licence to fly a Gyro and carry passengers when they are satisfied that:

- the student has completed all the elements of the syllabus satisfactorily
- the student has flown at least the minimum number of hours required under the supervision of a CAA approved instructor.

Part 1 - The flying elements

There are 8 sections in the flying syllabus:

- 1: Basic Flying
- 2: Upper Air Work
- 3: Rotor management, take off and landing
- 4: Emergencies
- 5: Solo Flying
- 6: Advanced Flying
- 7: Cross Country Flying
- 8: General Flying Test

In general a student would be proficient in a section before starting training in the next section.

Each flying section is subdivided into **exercises**. An exercise is a `bite size` step in the training which will be covered in one or more training flights.

For example, the section on Upper Airwork contains an exercise called:

Ex 2b: Increase and decrease speed at constant altitude

There is no prescribed order for exercises, the order may vary depending upon the weather, the instructor's preference and the student's learning ability. Although sections 6 and 7 appear in the syllabus after solo flying, it is likely that many of these exercises will be taught before solo flying and then revisited after solo flying as the student will have a greater capacity for concentrating on them having consolidated a few hours solo.

Each exercise has a **brief** which explains some of the vital content of the exercise. The details of the brief will be explained by your instructor.

Each exercise also has one or more **Specific Flying Objectives**. A specific flying objective is a skill that a pilot must be able to perform competently and consistently. This syllabus contains a standard for that skill level.

For example, the exercise above has a specific flying objective:

From straight and level flight at a constant speed in trim, increase speed by a suitable amount (say 20mph) and re-trim, maintaining balance and constant altitude at all times.

The flying elements of the syllabus are examined in a **General Flying Test** (GFT) by a CAA approved examiner. The general flying test consists of the student being able to demonstrate competency of a number of the specific flying objectives already performed during the course. It also involves a demonstration of the safe operation of the Gyro on the ground and the safety of passengers.

Part 2 - The theoretical elements

There are 6 theoretical sections to the syllabus:

- Airfield Procedures
- Aviation Law, Flight Rules and Procedures
- Gyroplane Technical
- Meteorology
- Human Performance and Limitations
- Navigation

With the exception of Airfield Procedures, the theoretical elements of the syllabus are examined by multiple choice paper.

Airfield Procedures has no examination as the content will be specific to your airfield. Your instructor must be satisfied that you understand and comply with these procedures at all times. You must seek out airfield procedures for any other airfield that you fly from.

There will be an oral exam with questions relating to the specific type of Gyro that you use for your General Flying Test. This is usually done immediately before the GFT.

In addition a student should sit the standard Radio Telephony Exam in order to legally use the radio in flight.

Minimum Flying Hours

A student must complete a minimum of 40 hours of instruction of which at least 10 hours must be flown solo and at least 3 hours must be solo flown outside the locality of the home airfield and training area (cross country).

An existing NPPL or PPL(A) or PPL(H) holder (or above) will be granted a credit of up to 15 hours towards the training. The minimum solo hours and solo navigation hours given above must still be done.

Single Seat Training

A student must be suitably trained on a dual seat Gyro before attempting flying exercises in a single seat Gyro, however there are certain non-flying exercises eg Rotor Start/Stop that can be trained in parallel with dual seat training. Training on a single seat Gyro may be interspersed with dual seat training at the discretion of the instructor. A student must be at solo standard in a dual seat machine before flying in a single seat machine.

Completion of Theory Exams

Air Law must be completed before flying solo.

Navigation, Meteorology and Human Performance and Limitations must be completed before flying solo cross country.

All exams must be taken within 24 months of the application for a licence.

Standards Document 44

The information given above is correct at the date of this publication however it may be superseded by the CAA at any time. Please refer to the CAA publication Standards Document 44 for the latest licencing requirements.

Recording of Student Progress

An instructor will maintain his own training notes relating to the exercises performed and standards achieved during training with a student however it is vital that both an instructor and the student have confidence that what has been **taught** during the training has actually been learned **and retained** by the student.

A student must therefore be able to perform every Specific Flying Objective in this syllabus competently before applying for the General Flying Test. There are 3 stages to learning that may be noted in this syllabus to record progress.

- Firstly, when the student has been initially **taught** to fly an objective, the **instructor** should sign and date when it has been taught.
- Secondly, on a different flight, when the student has **consolidated** the objective and is confident that he/she can demonstrate consistently the objective to the standard set out in this syllabus, the **student** should sign and date the objective.
- Thirdly, when the instructor is satisfied that the student has **proved** him/herself demonstrating the exercise on demand to the required standard, the **instructor** should sign and date the objective.

At the end of this syllabus there is a certificate of completion that both the student and the instructor should sign to confirm that student has been able to demonstrate all the exercises competently and consistently during the training. This will be checked by the examiner prior to the General Flying Test.

Pilot's Operating Handbook, Aviation Law and Good Practice

Nothing in this document overrides the requirement to operate the aircraft within the limitations of the Pilots Operating Handbook (POH), the aircraft's Permit to Fly, Aviation Law and good aviation practice.

Syllabus for the PPL(G)

2009 Edition Rev C

Part 1 - The Flying Elements

The PPL(G) Syllabus 2009 Edition

Section 1: Basic Flying

- Ex 1a: Air Experience Flight
- Ex 1b: Effects of controls
- Ex 1c: Startup, Taxi and Shutdown
- Ex 1d: Basic Flying Consolidation

Section 2: Upper Air Work

- Ex 2a: Fly a straight track at constant altitude
- Ex 2b: Increase and decrease speed at constant altitude
- Ex 2c: Medium turns at constant altitude
- Ex 2d: Climb and descend - straight
- Ex 2e: Climb and descend whilst turning
- Ex 2f: Fly the circuit pattern
- Ex 2g: Upper Air Work Consolidation

Section 3: Rotor Management, take offs and landings

- Ex 3a: Rotor management
- Ex 3b: Take-offs
- Ex 3c: Landings
- Ex 3d: Hops
- Ex 3e: Circuit Consolidation

Section 4: Emergencies

- Ex 4a: Engine failures to touchdown at the airfield
- Ex 4b: Engine failure in the circuit, unable to reach the airfield
- Ex 4c: Engine failure on take off
- Ex 4d: Emergencies
- Ex 4e: Recognising and recovery from unusual attitudes

Section 5: Solo Flying

- Ex 5a: Presolo - check
- Ex 5b: First solo
- Ex 5c: Solo consolidation

Section 6: Advanced Flying

- Ex 6a: Advanced take offs
- Ex 6b: Advanced Landings
- Ex 6c: Slow Flight
- Ex 6d: Fast Flight
- Ex 6e: Vertical descents
- Ex 6f: Advanced Turns
- Ex 6g: Low flying
- Ex 6h: Advanced Rotor Management

Section 7: Cross country flying

Ex 7a: Join the circuit at unfamiliar airfields

Ex 7b: Precautionary Field landings

Ex 7c: Emergency field landing

Ex 7d: Navigation

Ex 7e: Qualifying Cross country

Section 8: General flying test

Ex 8a: Pre-GFT check

Ex 8b: General Flying Test

Section 1: Basic Flying

`Basic Flying` is an introduction to flying Gyros. It contains the necessary elementary skills to control a Gyro holding a steady height and a steady speed, in a relaxed and controlled manner.

The aim of this section is to be comfortable in the air and understand the flying controls, to control the Gyro on the ground and in the air.

There are 4 basic flight exercises:

Ex 1a: Air Experience Flight

To introduce and become accustomed to the Gyro, the sensation of flying and to sample the aspect of the ground from the air.

Ex 1b: Effects of controls

To be able to understand the basic requirements of safe flying and the elementary use of the controls in the air.

Ex 1c: Startup, Taxi and Shutdown

To be able to safely start, taxi, prerotate and stop a Gyro and understand the use of the controls on the ground.

Ex 1d: Basic Flying Consolidation

To be able to fly a Gyro at a steady height and speed, making gentle turns in a controlled manner, in balance and in trim.

Ex 1a: Air Experience Flight

Objective

To introduce and become accustomed to the Gyro, the sensation of flying and to sample the aspect of the ground from the air.

Brief

- General understanding of a Gyro
- Safety Brief
- Operating the Gyro from the pilot's seat (If applicable)
- No big movements of the stick

Specific Flying Objectives

Specific Flying Objective	Completed
Instructor led flight with hands-on experience Fly in a Gyro with the instructor doing the flying to experience the sensation of Gyro flying. Have the opportunity to take the controls whilst in flight.	

Ex 1b: Effects of controls

Objective

To be able to understand the basic requirements of safe flying and the elementary use of the controls in the air.

Brief

- The controls: Stick, Throttle and Pedals
- Reducing the stick pressure: flying in trim
- Basic Terminology
- Student/Instructor handover
- Lookout for other traffic
- Understanding the instruments

Specific Flying Objectives

Specific Flying Objective	Completed
Seating position and control movement Having a comfortable seating position, using a cushion where necessary ensuring that all the controls can be reached without stretching. The correct way to move the controls, in particular the correct grip of the stick.	Trained Consolidated Proved
Instructor/Student handover Understand and use the `I have control - You have control` technique to ensure that there is no ambiguity who is flying the Gyro.	Trained Consolidated Proved
Relaxed Flying Demonstrate a sufficiently relaxed manner when flying and to be able to talk to and listen to the instructor in flight.	Trained Consolidated Proved
Reference to the instruments Understand how to interpret the instruments in the Gyro. Get the balance correct between flying with reference to the horizon and scanning the instruments.	Trained Consolidated Proved
Maintain a good lookout Fly whilst maintaining a good lookout, spotting other aircraft and be able to use the `clock code` to pinpoint other aircraft. The importance of not assuming the instructor has seen everything.	Trained Consolidated Proved

Ex 1c: Startup, Taxi and Shutdown

Objective

To be able to safely start, taxi, prerotate and stop a Gyro and understand the use of the controls on the ground.

Brief

- The Anatomy of an airfield
- Handling a Gyro on the ground, Blade Flap
- Prestart Checklist,Startup Checklist
- Use of controls when Taxiing
- Runway Checklist
- Pre-rotating
- Post Flight Checklist

Specific Flying Objectives

Specific Flying Objective	Completed
Prestart procedure Correct positioning of the Gyro prior to start with consideration to other people and aircraft in the vicinity. Check essential elements before starting the engine.	Trained Consolidated Proved
Startup procedure Start the engine of the Gyro with due consideration for safety and check for satisfactory performance of an engine before flying. Particular care to be taken to avoid risk to bystanders.	Trained Consolidated Proved
Taxi procedure (rotors stationary) Move the Gyro on the ground in a controlled manner, turning left and right, keeping an appropriate speed with care and attention to obstacles on the ground. Be able to stop in an emergency. Be able to shut down the engine in an emergency.	Trained Consolidated Proved
Prerotate procedure Perform appropriate checks before take-off and prerotate in a safe and controlled manner, handing over control to the instructor for take-off.	Trained Consolidated Proved
Rotor brake application procedure Understand how to manoeuvre a Gyro on the ground after landing and apply the rotor brake (if fitted) to stop the rotors. Align the rotors fore and aft if possible when Taxiing.	Trained Consolidated Proved
Shut down and park procedure Correctly manoeuvre a Gyro back to the apron and park with due consideration to people and other traffic. Correct shutting down of the engine and post flight procedures.	Trained Consolidated Proved

Ex 1d: Basic Flying Consolidation

Objective

To be able to fly a Gyro at a steady height and speed, making gentle turns in a controlled manner, in balance and in trim.

Brief

- The Primary, Secondary and Tertiary effects of controls
- Understanding power and pitch relationship
- Understanding stick back pressure on turning
- Understanding Balance
- Understanding Trim
- Understanding Stick Forces
- Pilot Induced Oscillation

Specific Flying Objectives

Specific Flying Objective	Completed
Hold a steady speed Fly consistently at a steady speed suitable for general training. Speed should be held steady +/- 10mph. Pitch adjusted without over-controlling.	Trained Consolidated Proved
Hold a steady height Fly consistently at a constant altitude suitable for general training. Altitude should be held steady +/- 100 ft. Power adjusted without over-controlling.	Trained Consolidated Proved
Fly in Balance Fly consistently with the airflow in balance around the Gyro including gentle turns. Understand the factors that influence balance. Balance should be adjusted without over-controlling.	Trained Consolidated Proved
Fly in Trim Where in-flight adjustable trim is fitted, trim to be adjusted for near \`hands-off\` flight consistently and whenever speed is altered. Trim to be adjusted in the correct direction and for an appropriate duration without over-controlling.	Trained Consolidated Proved
Airmanship Understand \`Airmanship\`, maintaining a good lookout for other traffic, being able to have a general sense of direction and recognise local features to navigate back to the airfield. Have due consideration for other people and traffic whilst in the air and whilst on the ground.	Trained Consolidated Proved

Section 2: Upper Air Work

`Upper Airwork` adds finesse to flying Gyros whilst in the air. This includes changing speed, changing height and changing direction in a controlled manner.

The aim of this section is to be able to fly a Gyro accurately whilst in the air, it excludes being able to take-off and land.

Ex 2a: Fly a straight track at constant altitude

To be able to fly in a straight line over the ground irrespective of where the wind is coming from and remain at a constant altitude.

Ex 2b: Increase and decrease speed at constant altitude

To be able to change speed significantly whilst remaining at a constant altitude.

Ex 2c: Medium turns at constant altitude

To be able to change direction significantly at a constant speed whilst remaining at a constant altitude.

Ex 2d: Climb and descend - straight

To be able to change height significantly at a suitable speed and constant direction.

Ex 2e: Climb and descend whilst turning

To be able to change height significantly at a constant speed whilst changing direction.

Ex 2f: Fly the circuit pattern

To be able to fly an accurate circuit pattern for the airfield.

Ex 2g: Upper Air Work Consolidation

To be able to perform all the upper airwork exercises competently and confidently.

Ex 2a: Fly a straight track at constant altitude

Objective

To be able to fly in a straight line over the ground irrespective of where the wind is coming from and remain at a constant altitude.

Brief

- Wind Direction Terminology
- Picking ground track objects
- Wind signals

Specific Flying Objectives

Specific Flying Objective	Completed
Maintain a track in a headwind at constant altitude Fly in a straight line over the ground directly into wind, in balance and in trim whilst maintaining a height +/- 100ft, a speed +/- 10mph. Recognising \`into wind\` from ground speed and other wind signals.	Trained Consolidated Proved
Maintain a track in a tailwind at constant altitude Fly in a straight line over the ground downwind, in balance and in trim whilst maintaining a height +/- 100ft, a speed +/- 10mph. Recognising \`tail wind\` from ground speed and other wind signals.	Trained Consolidated Proved
Maintain a track in a crosswind from the right at constant altitude Fly in a straight line over the ground with a medium strength (say 15mph) wind coming from the right. Maintain a suitable crab angle to compensate for drift.	Trained Consolidated Proved
Maintain a track in a crosswind from the left at constant altitude Fly in a straight line over the ground with a medium strength (say 15mph) wind coming from the left. Maintain a suitable crab angle to compensate for drift.	Trained Consolidated Proved

Ex 2b: Increase and decrease speed at constant altitude

Objective

To be able to change speed significantly whilst remaining at a constant altitude.

Brief

- Relationship between power and pitch
- Simultaneous adjustment
- Reminder of balance changes with power and airspeed
- Remember to re-trim

Specific Flying Objectives

Specific Flying Objective	Completed
Significant increase in speed at constant altitude From straight and level flight at a constant speed in trim, increase speed by a suitable amount (say 20mph) and re-trim, maintaining balance and constant altitude at all times.	Trained Consolidated Proved
Significant decrease in speed at constant altitude From straight and level flight at a constant speed in trim, decrease speed by a suitable amount (say 20mph) and re-trim, maintaining balance and constant altitude at all times.	Trained Consolidated Proved

Ex 2c: Medium turns at constant altitude

Objective

To be able to change direction significantly at a constant speed whilst remaining at a constant altitude.

Brief

- Rotor thrust direction
- Loss of either speed or height
- Importance of lookout
- Don't look at the compass whilst turning

Specific Flying Objectives

Specific Flying Objective	Completed
Change heading by 360 deg to the right at constant altitude From straight and level flight, change direction to the right keeping a constant bank angle and in balance. Maintain level flight +/- 100ft. During the turn speed to be constant +/- 10mph. Maintain a good lookout at all times, especially before the turn commences. Note speed in turn generally slower than speed at entry.	Trained Consolidated Proved
Change heading by 360 deg to the left at constant altitude From straight and level flight, change direction to the left keeping a constant bank angle and in balance. Maintain level flight +/- 100ft. During the turn speed to be constant +/- 10mph. Maintain a good lookout at all times, especially before the turn commences. Note speed in turn generally slower than speed at entry.	Trained Consolidated Proved
Turn onto a heading From straight and level flight, change direction to the left and/or the right keeping a constant bank angle and in balance. Exit the turn to a given compass heading. Maintain level flight +/- 100ft. During the turn speed to be constant +/- 10mph. Maintain a good lookout at all times, especially before the turn commences.	Trained Consolidated Proved

Ex 2d: Climb and descend - straight

Objective

To be able to change height significantly at a suitable speed and constant direction.

Brief

- Climbing Terminology
- Relationship between power and pitch
- Simultaneous adjustment
- Importance of lookout
- The cruise climb and descent
- The zoom climb and descent

Specific Flying Objectives

Specific Flying Objective	Completed
Full power climb and level out. Constant speed From straight and level flight climb on full power to a given altitude at least 300ft above the starting altitude maintaining a constant speed and direction and maintaining balance at all times. Fly at a constant altitude after levelling out.	Trained Consolidated Proved
Low power descend and level out. Constant speed From straight and level flight descend on idle power to a given altitude at least 300ft below the starting altitude maintaining a constant speed and direction and maintaining balance at all times. Fly at a constant altitude after levelling out.	Trained Consolidated Proved
Full power climb into a low power descent From straight and level flight climb on full power to a given altitude at least 300ft above the starting altitude maintaining a constant speed and direction and maintaining balance at all times. As soon as the given height is reached, immediately descend on idle power levelling out at the original altitude.	Trained Consolidated Proved
Low power descent into a full power climb From straight and level flight descend on low power to a given altitude at least 300ft below the starting altitude maintaining a constant speed and direction and maintaining balance at all times. As soon as the given height is reached, immediately climb on full power levelling out at the original altitude.	Trained Consolidated Proved

Ex 2e: Climb and descend whilst turning

Objective

To be able to change height significantly at a constant speed whilst changing direction.

Brief

- The relationship between bank angle and rate of climb

Specific Flying Objectives

Specific Flying Objective	Completed
Climbing, initiating a 360 turn in the climb and then straight From straight and level flight, climb on full power on a constant heading, after 100ft of climb initiate a 360 deg turn to the left whilst maintaining a (reduced) climb. After 360 deg continue climbing on the original heading. Maintain speed and balance at all times. Repeat the exercise turning to the right.	Trained Consolidated Proved
Descending, initiating a 360 turn in the descent and then straight From straight and level flight, descend on low power on a constant heading, after 100ft of descent initiate a 360 deg turn to the left whilst maintaining an increased descent. After 360 deg continue descending on the original heading. Maintain speed and balance at all times. Repeat the exercise turning to the right.	Trained Consolidated Proved
Level 360 turn and then climb during the turn to level out in the turn From a constant bank angle turn to the left at a constant speed and altitude, climb on full power whilst maintaining speed and bank angle. After 360 deg continue turning at level altitude. Maintain balance at all times. Repeat the exercise whilst turning to the right.	Trained Consolidated Proved
Level 360 turn and then descend during the turn to level out in the turn From a constant bank angle turn to the left at a constant speed and altitude, descend on low power whilst maintaining speed and bank angle. After 360 deg continue turning at level altitude. Maintain balance at all times. Repeat the exercise whilst turning to the right.	Trained Consolidated Proved

Ex 2f: Fly the circuit pattern

Objective

To be able to fly an accurate circuit pattern for the airfield.

Brief

- Circuit Terminology
- Downwind checks - LIFES (or equivalent)
- Check "Clear Final"
- Check "Clear Runway"
- Go-around

Specific Flying Objectives

Specific Flying Objective	Completed
Circuit pattern, left hand Fly a left hand circuit pattern using full power on climb out, levelling out to circuit height +/- 50ft flying at a constant speed +/- 5mph, descending on the approach at near idle power, using an initial descent point aiming at the numbers at the start of runway. Maintain balance at all times. Perform Downwind checks and check Final. Initiate a go-around at an appropriate height, alternatively the instructor may perform the landings and the take-offs.	Trained Consolidated Proved
Circuit pattern, right hand Fly a right hand circuit pattern using full power on climb out, levelling out to circuit height +/- 50ft flying at a constant speed +/- 5mph, descending on the approach at near idle power, using an initial descent point aiming at the numbers at the start of runway. Maintain balance at all times. Perform Downwind checks and check Final. Initiate a go-around at an appropriate height, alternatively the instructor may perform the landings and the take-offs.	Trained Consolidated Proved

Ex 2g: Upper Air Work Consolidation

Objective

To be able to perform all the upper airwork exercises competently and confidently.

Brief

- LIFER checks (or equivalent)
- Adjusting the altimeter when away from the airfield
- Joining the circuit at the home airfield
- Using the radio

Specific Flying Objectives

Specific Flying Objective	Completed
Perform LIFE checks (or equivalent) at regular intervals whilst flying Whilst flying away from the airfield in the cruise perform LIFE checks (or equivalent) at regular intervals (say every 10 mins) to ensure safe flying.	Trained Consolidated Proved
Join the circuit at the home airfield Understand the different ways to join the circuit at your home airfield(s). Fly each of the appropriate joins depending upon circuit traffic and the direction of joining.	Trained Consolidated Proved

Section 3: Rotor Management, take offs and landings

`Rotor Management` is about understanding how to control rotors safely on the ground, especially whilst they are speeding up before take off and slowing down after landing.

The aim of this section is to be able to take off and land a Gyro safely.

Ex 3a: Rotor management

To be able to control the rotors during their speed buildup and slowdown in a controlled manner whilst on the ground.

Ex 3b: Take-offs

To be able to take off from the runway in a safe and controlled manner.

Ex 3c: Landings

To be able to land on the runway in a safe and controlled manner.

Ex 3d: Hops

To be able to take off from the runway, fly level a few feet above the runway and land in a safe and controlled manner.

Ex 3e: Circuit Consolidation

To be able to fly an accurate circuit pattern, complete with take off and landings.

Ex 3a: Rotor management

Objective

To be able to control the rotors during their speed buildup and slowdown in a controlled manner whilst on the ground.

Brief

- Blade Sailing, Bumpy Ground
- Retreating Blade Stall
- Rotor Thrust/Rotor Drag
- Stick position when on the ground

Specific Flying Objectives

Specific Flying Objective	Completed
Increasing power safely, with due attention to rotor speed, anticipating the front wheel lifting From a position at the start of the runway, with the rotors prerotated to the manufacturers recommended RPM, apply power and move forward, keeping the Gyro in a straight line and build rotor speed, with due care and attention to avoiding blade sailing. Be able to consistently anticipate when the nosewheel is about to lift.	Trained Consolidated Proved
Wheel Balance Move down the runway with the main wheels touching the ground at all times, with the nosewheel lifted a few inches above the ground. Keep the Gyro in full control at all times, without lifting off or over-controlling.	Trained Consolidated Proved
Taxi with stick forward including turning at each end of the runway With the rotors turning at a suitable speed, Taxi in both directions on the runway turning 180 deg at each end with the stick fully forward and in a position suitable for the current wind speed and direction.	Trained Consolidated Proved

Ex 3b: Take-offs

Objective

To be able to take off from the runway in a safe and controlled manner.

Brief

- Alignment
- Prerotate
- Rotorspeed Build up
- Lift Off
- Airspeed Buildup
- Climb out

Specific Flying Objectives

Specific Flying Objective	Completed
Take-offs with headwind or light crosswind With a headwind or light crosswind, take off in a straight line keeping the Gyro controlled at all times, without over-controlling.	Trained Consolidated Proved
Take-offs with medium crosswind from the right With medium wind conditions (say 10-15mph), crosswind from the right, take off keeping the Gyro in a straight line down the runway.	Trained Consolidated Proved
Take-offs with medium crosswind from the left With medium wind conditions (say 10-15mph), crosswind from the left, take off keeping the Gyro in a straight line down the runway.	Trained Consolidated Proved
Take-offs with limited performance Emulating poor performance characteristics (hot temperature, high humidity, low air pressure) with limited power available during take off, understand the need and demonstrate the ability to abort the take off at or before a predetermined safe abort point.	Trained Consolidated Proved
Aborting take offs Before every take off, think about aborting during the take off process should anything not be normal. Abort take offs at any point in the take off process.	Trained Consolidated Proved

Ex 3c: Landings

Objective

To be able to land on the runway in a safe and controlled manner.

Brief

- Initial Descent Point, Approach, Roundout, Float, Flare

Specific Flying Objectives

Specific Flying Objective	Completed
Landings with headwind or light crosswind With a headwind or light crosswind, land in straight line. The touchdown to be on the main wheels with a very small rate of descent at the time of touchdown. The Gyro must be pointing accurately in the direction of travel. After touchdown use the rotor drag to bring the Gyro to a complete halt in the shortest possible time.	Trained Consolidated Proved
Landings with medium crosswind from the right With medium wind conditions (say 10-15mph) crosswind from the right, land in straight line avoiding any tendency to drift. The touchdown to be on the main wheels with a very small rate of descent at the time of touchdown. The Gyro must be pointing accurately in the direction of travel. After touchdown use the rotor drag to bring the Gyro to a complete halt in the shortest possible time.	Trained Consolidated Proved
Landings with medium crosswind from the left With medium wind conditions (say 10-15mph) crosswind from the left, land in straight line avoiding any tendency to drift. The touchdown to be on the main wheels with a very small rate of descent at the time of touchdown. The Gyro must be pointing accurately in the direction of travel. After touchdown use the rotor drag to bring the Gyro to a complete halt in the shortest possible time.	Trained Consolidated Proved
Landings into wind, in a crosswind With medium wind conditions (say 10-15mph) crosswind, land directly into wind at an angle up to 30 deg on a runway. The touchdown to be on the main wheels with a very small rate of descent at the time of touchdown. The Gyro must be pointing accurately in the direction of travel. After touchdown use the rotor drag to bring the Gyro to a complete halt in the shortest possible time.	Trained Consolidated Proved

Ex 3d: Hops

Objective

To be able to take off from the runway, fly level a few feet above the runway and land in a safe and controlled manner.

Brief

- The three phases of a hop
- Taking off
- Flying a low hop
- Landing from a low hop
- The height-velocity diagram for a Gyro
- The power curve
- Flying a high hop
- Landing from a high hop

Specific Flying Objectives

Specific Flying Objective	Completed
Low hops From a stationary position at the start of a runway, take off and fly level a few feet above the ground at a steady speed close to the minimum drag speed for the Gyro, keeping straight along the length of the runway. Land the Gyro at the end of the runway.	Trained Consolidated Proved
High hops From a stationary position at the start of a runway, take off and fly at about 100ft above the ground at a steady speed close to the minimum drag speed for the Gyro, keeping straight along the length of the runway. Land the Gyro at the end of the runway.	Trained Consolidated Proved

Ex 3e: Circuit Consolidation

Objective

To be able to fly an accurate circuit pattern, complete with take off and landings.

Brief

- Adjusting power during an approach
- Landing with idle power
- Correcting from a balloon
- Reacting to an impromptu go-around
- Flying the approach in a crosswind in balance
- Landing directly into wind

Specific Flying Objectives

Specific Flying Objective	Completed
Landing without power close to a selected point Take off, fly an accurate circuit and land with idle power, coming to a full stop without applying the wheel brake. The landing must be smooth with no tendency to drift.	Trained Consolidated Proved
Landings with power close to a selected point Take off, fly an accurate circuit and land with low power, coming to a full stop without applying the wheel brake. The landing must be smooth with no tendency to drift.	Trained Consolidated Proved
Recognising and correct action of a go-around Take off, fly an accurate circuit and continue as if to land. During the final stages of the float apply power to go-around without touching the runway. The go-around must be smooth with no significant changes in direction, over-controlling or loss of balance.	Trained Consolidated Proved

Section 4: Emergencies

\`Emergencies\` is dealing with unexpected events including safe operation of a Gyro and landing in the event of an engine failure.

The aim of this section is to be instinctive about coping with an emergency situation.

Ex 4a: Engine failures to touchdown at the airfield

To be able to land on the runway in the event of an engine failure close to the runway.

Ex 4b: Engine failure in the circuit, unable to reach the airfield

To be able to land in a safe area in the event of an engine failure when in the circuit but not close to the runway.

Ex 4c: Engine failure on take off

To be able to land ahead on the runway in the event of an engine failure on take off.

Ex 4d: Emergencies

To be able to take corrective action in the event of emergency situations.

Ex 4e: Recognising and recovery from unusual attitudes

To be able to recognise unusual attitudes and safely recover from them.

Ex 4a: Engine failures to touchdown at the airfield

Objective

To be able to land on the runway in the event of an engine failure close to the runway.

Brief

- Landing ahead from a glide approach
- Shortening the approach distance using S-turns
- Shortening the approach distance using speed reduction

Specific Flying Objectives

Specific Flying Objective	Completed
Engine failure landings on approach Perform a normal circuit. At a point on final approach where you can safely reach the runway, chop the power to idle and land straight ahead. Apply power only to go-around if necessary.	Trained Consolidated Proved
Engine failure landings on approach - S turns Perform a normal circuit, continue on final approach past the normal initial descent point. Chop the power to idle, perform S-turns and land at the usual touchdown point on the runway.	Trained Consolidated Proved
Engine failure landings on approach - speed reduction Perform a normal circuit, continue on final approach past the normal initial descent point. Chop the power to idle, reduce airspeed to a minimum suitable airspeed for the Gyro that still gives rudder authority and descend until the normal glide approach is re-established or the minimum safe height. Increase speed to a safe landing speed and touchdown on the runway.	Trained Consolidated Proved
Engine failure landings on downwind leg Perform a normal circuit (or a tight circuit if suitable). At a point past the midpoint on the downwind leg, chop the power. Perform a 180deg turn and land.	Trained Consolidated Proved
Engine failure landings from overhead the airfield Fly overhead the airfield at a height roughly equal to double the circuit height (as a guide). Chop the power and position the Gyro directly to a position suitable for landing on the runway. Perform an idle power landing. Ensure that no other circuit traffic will be affected by this manoeuvre.	Trained Consolidated Proved

Ex 4b: Engine failure in the circuit, unable to reach the airfield

Objective

To be able to land in a safe area in the event of an engine failure when in the circuit but not close to the runway.

Brief

- The procedure for simulated engine failures in the circuit
- Simulated engine failure on climb-out
- Simulated engine failure on the crosswind leg
- Simulated engine failure on the downwind leg
- Simulated engine failure on base leg or final approach

Specific Flying Objectives

Specific Flying Objective	Completed
Engine failures on climb out Perform a normal circuit, at a suitable point on the climb-out (say at least 300ft) chop the power and approach for landing ahead. DO NOT ATTEMPT TO TURN BACK TO THE RUNWAY. Go around at a suitable height.	Trained Consolidated Proved
Engine failures on crosswind leg Perform a normal circuit, at a suitable point on the crosswind leg chop the power and approach for landing into wind. DO NOT ATTEMPT TO TURN BACK TO THE RUNWAY. Go around at a suitable height.	Trained Consolidated Proved
Engine failures on downwind leg Perform a normal circuit, at a suitable point before the midpoint of the downwind leg chop the power and take decisive action about where to land, If suitable for landing then touchdown otherwise go-around at a suitable height.	Trained Consolidated Proved

Ex 4c: Engine failure on take off

Objective

To be able to land ahead on the runway in the event of an engine failure on take off.

Brief

- A reminder of the height-velocity curve
- The high loss of airspeed with an engine failure in a nose high attitude
- Engine failure during the speed build-up phase
- Engine failure during the early climb-out

Specific Flying Objectives

Specific Flying Objective	Completed
Engine failure during speed build up Perform a normal take off, as the airspeed is increasing with the Gyro flying level a few feet above the ground, chop the power and land ahead. The Gyro must not significantly go out of balance or drift during the exercise.	Trained Consolidated Proved
Engine failure during early climb out Perform a normal take off, soon after the climb-out is started, having achieved a suitable climb-out speed and safe height for the manoeuvre, chop the power and land ahead. If there is not a suitable length of runway remaining - go-around at a suitable height.	Trained Consolidated Proved

Ex 4d: Emergencies

Objective

To be able to take corrective action in the event of emergency situations.

Brief

- Partial Engine Failure,Trim Failure
- Throttle Cable Failure,Fire, Control Failure

Specific Flying Objectives

Specific Flying Objective	Completed
Limited power flying and landing Take off as if to fly a normal circuit, at about 200ft on the climbout reduce power to about 3/4 of full power (simulating an engine cylinder failure). Take appropriate action to land safely on the ground.	Trained Consolidated Proved
Simulated throttle cable break (if appropriate for the Gyro) Take off as if to fly a normal circuit, at about 200ft on the climbout apply full power (possibly simulating a throttle cable break). Take appropriate action and land back on the runway. You only have 2 power settings - full power or idle power.	Trained Consolidated Proved
Simulated trim failure - full rear trim (if appropriate for the Gyro) Take off as if to fly a normal circuit, at about 200ft on the climbout apply full trim backwards. Continue to fly the circuit with this excessive back pressure and land normally. If there is any doubt that a satisfactory landing can be achieved, go-around and land with a normal trim setting.	Trained Consolidated Proved
Simulated trim failure - full forward trim (if appropriate for the Gyro) Take off as if to fly a normal circuit, at about 200ft on the climbout apply full forward trim. Continue to fly the circuit with this excessive forward pressure and land normally. If there is any doubt that a satisfactory landing can be achieved, go-around and land with a normal trim setting.	Trained Consolidated Proved
Simulated fire in the air Take off as if to fly a normal circuit, or fly away from the airfield. Simulate an engine fire and TALK THROUGH ONLY any actions to take. Repeat the exercise with an electrical fire.	Trained Consolidated Proved
Simulated fire on the ground Whilst Taxiing, simulate an engine fire and TALK THROUGH ONLY any actions to take. Repeat the exercise with an electrical fire.	Trained Consolidated Proved

Ex 4e: Recognising and recovery from unusual attitudes

Objective

To be able to recognise unusual attitudes and safely recover from them.

Brief

- These exercises must only be done with an instructor
- HASEL checks
- The standard recovery technique
- Discussion of a tail slide

Specific Flying Objectives

Specific Flying Objective	Completed
Recovery from rapid stick back movement and nose high attitude Fly straight and level. Without adjusting power lower the nose to increase to a significant speed appropriate for the exercise and pull back on the stick to climb in a nose high attitude. Recognise this unusual attitude and recover safely.	Trained Consolidated Proved
Recovery from a nose low attitude with power and speed close to VNE Fly straight and level with cruise power. Gently lower the nose significantly and let the speed build close the VNE. Recognise this unusual attitude and recover safely.	Trained Consolidated Proved
Recovery from slow speed descending turn Fly straight and level. Without adjusting power gradually bring the stick back to reduce speed, apply some pedal and stick in the same direction to enter a slow spiral descent. Recognise this unusual attitude and recover safely.	Trained Consolidated Proved
Recovery from high speed descending turn Fly straight and level. Without adjusting power introduce roll left and/or right without applying back pressure on the stick. The aircraft will enter a high speed spiral descent. Recognise this unusual attitude and recover safely before speed reaches VNE.	Trained Consolidated Proved
Recovery from a zero airspeed flat spin (demo by instructor) With power at idle, reduce airspeed to zero to induce a loss of airflow over the rudder. Allow the aircraft to develop a rotation to the right. Recover by adding power or by increasing airspeed.	Trained Consolidated Proved

Section 5: Solo Flying

At this stage you will have the competence to fly accurately and deal with emergency situations. The aim of this section is to build confidence to fly a Gyro on your own and consolidate all your training, within the general locality of an airfield.

Ex 5a: Presolo - check

To be assessed for readiness for a first solo.

Ex 5b: First solo

To perform a first solo flight.

Ex 5c: Solo consolidation

To consolidate solo flying and obtain consistency and accuracy of flying in solo circumstances.

Ex 5a: Presolo - check

Objective

To be assessed for readiness for a first solo.

Brief

- Exercises signed off
- Air Law exam
- A signed medical form
- Ballast
- The characteristics of solo flight
- Two techniques to make solo flight feel familiar

Specific Flying Objectives

Specific Flying Objective	Completed
Perform take offs and landing competently and consistently With ALL of the previous exercises signed off, perform a suitable number consecutive take offs and landings flown with accurate circuits. At least one of the circuits must include a self initiated go-around either due to the recognition of a possible unsatisfactory landing or the simulation of a runway intrusion.	Trained Consolidated Proved

Ex 5b: First solo

Objective

To perform a first solo flight.

Brief

- Mental Attitude
- Weather Conditions

Specific Flying Objectives

Specific Flying Objective	Completed
First solo Perform at least one circuit being the only occupant of the Gyro, landing safely. Perform go-arounds if there is any uncertainly in the landing.	Trained Consolidated Proved

Ex 5c: Solo consolidation

Objective

To consolidate solo flying and obtain consistency and accuracy of flying in solo circumstances.

Brief

- Making the decision to go flying
- Only fly according to the brief except if flight safety is compromised

Specific Flying Objectives

Specific Flying Objective	Completed
Solo circuit consolidation As the only occupant in the Gyro, fly accurate circuits, coming to a full stop landing before each take-off.	Trained Consolidated Proved
Solo local area consolidation As the only occupant in the Gyro, fly around the local area as briefed previously by your instructor. Rejoin the circuit and land.	Trained Consolidated Proved
Solo consolidation of flying skills As the only occupant in the Gyro, fly to a suitable area as briefed by your instructor and consolidate your flying skills of all exercises signed off to date. Pay particular attention to maintaining a given height and speed during an exercise and flying in balance and in trim. MAINTAIN A SUITABLE LOOKOUT AT ALL TIMES when concentrating on an exercise.	Trained Consolidated Proved

Section 6: Advanced Flying

`Advanced flying` is about being able to understand and fly a Gyro within the majority of the range of its flight envelope. The aim of this section is to be able to fly more accurate landings, with and without power, flying at a slow and fast airspeed and flying safely at a relatively low level. It is about flying and thinking like a Gyro pilot.

ALL OF THESE EXERCISES ARE DUAL EXERCISES. These exercises may be done pre-solo as determined by your instructor, however it is good practice to consolidate these exercises after some solo work when the workload capacity of the student will be more suitable for these types of exercises.

Ex 6a: Advanced take offs

To be able to perform takeoffs in the shortest possible distance eg. when the ground surface is poor or the circuit is busy.

Ex 6b: Advanced Landings

To be able to land within close proximity to a given point, with and without power.

Ex 6c: Slow Flight

To be able to fly at the slowest speed possible without losing height.

Ex 6d: Fast Flight

To be able to fly at the fastest speed possible in a controlled and accurate manner.

Ex 6e: Zero airspeed descents

To be able to fly at a zero airspeed.

Ex 6f: Advanced Turns

To be able to turn the gyro safely at its maximum allowable bank angle.

Ex 6g: Low flying

To be able to fly the gyro accurately at low level and understand the importance and consequence of the effect of the wind, navigation and radio signals.

Ex 6h: Advanced Rotor Management

To be able to accelerate the rotors from a slow rotational speed to flying speed in a safe manner.

Ex 6a: Advanced take offs

Objective

To be able to perform takeoffs in the shortest possible distance eg. when the ground surface is poor or the circuit is busy.

Brief

- Technique for minimum ground distance
- Performance criteria for take-off distance
- Immediate departure take-off
- Taking off from a slope

Specific Flying Objectives

Specific Flying Objective	Completed
Performance Take-off, shortest ground run Prerotate to the maximum permitted by the manufacturer and after prerotation apply full power keeping the stick full back for as long as it is safe to do so, becoming airborne in the shortest possible distance. As the airspeed will be lower, ensure correct airspeed is obtained before starting to climb out.	Trained Consolidated Proved
Immediate departure takeoff Prerotate at the hold point BEFORE entering the runway. When ready to take off, Taxi to the runway with the rotors spinning and start rolling as soon as the Gyro is lined up without stopping. This is a necessary exercise when operating from busy airfields.	Trained Consolidated Proved

Ex 6b: Advanced Landings

Objective

To be able to land within close proximity to a given point, with and without power.

Brief

- The danger of fixating on the landing area
- Spot landings with power
- Spot landings without power
- Technique for landing on soft/uneven ground
- Landing on sloping ground

Specific Flying Objectives

Specific Flying Objective	Completed
Spot landings with power Perform a standard circuit with an aim to touchdown and stop at a predetermined point on the runway. Using power to adjust the glideslope, maintaining a suitable speed at all times land within -0/+100 metres of the predetermined point.	Trained Consolidated Proved
Spot landings without power Perform a standard circuit with an aim to touchdown and stop at a predetermined point on the runway. At a suitable point on the approach and above 500ft AGL, reduce the power to idle and using any technique previously taught, maintaining a suitable speed at all times land within +/-100 metres of the predetermined point. Apply power only in a go-around situation.	Trained Consolidated Proved

Ex 6c: Slow Flight

Objective

To be able to fly at the slowest speed possible without losing height.

Brief

- The power curve
- A "Hover"?
- Technique for flying slowly
- The hover taxi
- The dangers of flying behind the power curve

Specific Flying Objectives

Specific Flying Objective	Completed
Slow flight at altitude Fly straight and level at a safe height for this exercise. Gradually reduce speed, adjusting power as required to stay level, and fly the aircraft at the slowest speed possible for the Gyro without losing height. At the end of the exercise increase speed to a suitable cruise speed. Maintain balance at all times.	Trained Consolidated Proved

Ex 6d: Fast Flight

Objective

To be able to fly at the fastest speed possible in a controlled and accurate manner.

Brief

- Control responsiveness
- Understanding Va, the fastest safe manoeuvering speed

Specific Flying Objectives

Specific Flying Objective	Completed
Fast flight at altitude Whilst in a normal cruise flight, increase speed close to the VNE speed for the Gyro. Note the increased responsiveness. Fly for a few minutes at this speed performing gentle turns.	Trained Consolidated Proved

Ex 6e: Vertical descents

Objective

To be able to descend above a fixed point on the ground when the windspeed exceeds the minimum speed for safe level flight of the gyroplane.

Brief

- The need for airflow over the rudder
- The technique for establishing a vertical descent
- Recovery technique with power
- Recovery technique without power
- Importance of not over-pitching

Specific Flying Objectives

Specific Flying Objective	Completed
Descend over a point on the ground, recovery with power to achieve minimum further height loss. Starting from a normal cruise flying into wind, reduce power close to idle and reduce speed to the minimum speed allowed whilst maintaining enough airflow for rudder authority. Maintain the aircraft in balance and prevent any drift. At a height no less than 500ft recover by applying power. Ensure you are not in a nose down attitude when applying power. The aim of the exercise is to recover with minimum height loss.	Trained Consolidated Proved
Descend over a point on the ground, recover without power to a safe flying speed for landing Starting from a normal cruise flying into wind, reduce power close to idle and reduce speed to the minimum speed allowed whilst maintaining enough airflow for rudder authority. Maintain the aircraft in balance and prevent any drift. At a height no less than 500ft recover by lowering the nose. When an airspeed suitable for landing is achieved, maintain this airspeed until the instructor says the exercise is complete at which time add power and recover to the cruise.	Trained Consolidated Proved

Ex 6f: Advanced Turns

Objective

To be able to turn the gyro safely at its maximum allowable bank angle.

Brief

- Slipping and skidding turns
- The technique for a high bank angle turn
- Turning around a point on the ground

Specific Flying Objectives

Specific Flying Objective	Completed
Turn around a point on the ground to the right at constant altitude In a wind of at least 10mph, fly 360 deg turns to the right around a point on the ground keeping a constant distance from that point on the ground at all times and a constant altitude, changing the bank angle as appropriate to compensate for drift.	Trained Consolidated Proved
Turn around a point on the ground to the left at constant altitude In a wind of at least 10mph, fly 360 deg turns to the left around a point on the ground keeping a constant distance from that point on the ground at all times and a constant altitude, changing the bank angle as appropriate to compensate for drift.	Trained Consolidated Proved
Figures of 8 around 2 points on the ground at constant attitude In a wind of at least 10mph, fly figures of 8 around two points on the ground about 100m apart keeping a constant distance from the points on the ground at all times and a constant altitude, changing the bank angle as appropriate to compensate for drift.	Trained Consolidated Proved
Figures of 8 level, then whilst turning - climb to level. Constant speed Perform figures of 8 at a constant speed and height around 2 points approx 100metres apart. Initiate a full power climb to a given altitude at least 400ft above the starting altitude whilst maintaining the figure of 8 pattern. At the end of the climb continue on the figure of 8 pattern at level altitude.	Trained Consolidated Proved
Figures of 8 level, then whilst turning - descend to level. Constant speed Perform figures of 8 at a constant speed and height around 2 points approx 100metres apart. Initiate a low power descent to a given altitude at least 400ft below the starting altitude	Trained Consolidated Proved

whilst maintaining the figure of 8 pattern. At the end of the descent continue on the figure of 8 pattern at level altitude.	
Figures of 8 climbing, then descending, then climbing. Constant speed Perform figures of 8 at a constant speed and height around 2 points approx 100metres apart. Initiate a full power climb to a given altitude at least 400ft above the starting altitude whilst maintaining the figure of 8 pattern. At the end of the climb immediately initiate a low power descent whilst maintaining the figure of 8 pattern. At the end of the figure of 8 pattern immediately initiate a full power climb and repeat the exercise.	Trained Consolidated Proved
Steep turns to the left Fly at a suitable cruise height and speed. Make a 180 degree to the left at a bank angle of approximately 60 degrees, using increased power to maintain height. Ensure the Gyro is in balance at all times.	Trained Consolidated Proved
Steep turns to the right Fly at a suitable cruise height and speed. Make a 180 degree to the right at a bank angle of approximately 60 degrees, using increased power to maintain height. Ensure the Gyro is in balance at all times.	Trained Consolidated Proved

Ex 6g: Low flying

Objective

To be able to fly the gyro accurately at low level and understand the importance and consequence of the effect of the wind, navigation and radio signals.

Brief

- The legal issues of low flying
- The influence of the wind on low flying
- Terrain, wires, masts and cables
- The effect on radio communications
- Always think about an engine failure

Specific Flying Objectives

Specific Flying Objective	Completed
Low flying at safe height and speed Fly at a suitable safe height along a given track over the ground keeping a good lookout for masts and other obstacles. Ensure correct balance at all times. Keep attention on the wind speed and direction and be prepared for an engine failure at all times. Ensure a safe flying speed at all times.	Trained Consolidated Proved

Ex 6h: Advanced Rotor Management

Objective

To be able to accelerate the rotors from a slow rotational speed to flying speed in a safe manner.

Brief

- Blade sailing and retreating blade stall
- The technique for increasing rotor rpm

Specific Flying Objectives

Specific Flying Objective	Completed
Slow rotor buildup From a position at the start of the runway, prerotate until the rotors are turning at a relatively slow speed. Using slow application of power and correct use of the stick use airflow to increase the rotor RPM to flying speed. Be particularly aware of blade sailing at all times. The initial rotor RPM should be at the lowest level which allows rotor speed to be increased without the use of the prerotator.	Trained Consolidated Proved

Section 7: Cross country flying

Up until this point, the majority of your training will be in close proximity of the training airfield. `Cross Country Flying` is about flying between airfields without getting lost and safely flying in different classes of airspace, with consideration for other air traffic. The aim of this section is to give you the skills and confidence to tour with your Gyro.

Ex 7a: Join the circuit at unfamiliar airfields

To be able to join the circuit an airfield conforming to the circuit pattern and with consideration for other traffic.

Ex 7b: Precautionary Field landings

To be able to correctly select an appropriate field for landing and approach this field for landing.

Ex 7c: Emergency field landing

To be able to land in a field in the event of an engine failure.

Ex 7d: Navigation

To be able to safely navigate between two airfields without losing knowledge of the current position and land at different airfield.

Ex 7e: Qualifying Cross country

To perform the required cross country solo navigation exercises.

Ex 7a: Join the circuit at unfamiliar airfields

Objective

To be able to join the circuit an airfield conforming to the circuit pattern and with consideration for other traffic.

Brief

- Preparation for landing at an unfamiliar airfield
- The overhead join
- Radio calls

Specific Flying Objectives

Specific Flying Objective	Completed
Joining overhead From an exercise away from an airfield, return to an airfield correctly joining overhead, descending deadside and crosswind taking into account other traffic in the area. Perform downwind checks and check final.	Trained Consolidated Proved
Joining downwind / base leg From an exercise away from an airfield, join on the downwind leg taking account of other traffic in the area. Perform correct downwind checks and check final. Repeat the exercise joining on the base leg.	Trained Consolidated Proved

Ex 7b: Precautionary Field landings

Objective

To be able to correctly select an appropriate field for landing and approach this field for landing.

Brief

- How to select a suitable field
- Inspecting a field
- The landing

Specific Flying Objectives

Specific Flying Objective	Completed
Precautionary field landing From a general cruise speed and height select a suitable field for landing. Ensure there are no wires or obstructions in the vicinity of the field, perform a number of passes over the field to check the field's suitability for landing. Approach the field and land if you have permission, otherwise perform a go-around at an appropriate height.	Trained Consolidated Proved

Ex 7c: Emergency field landing

Objective

To be able to land in a field in the event of an engine failure.

Brief

- The technique for a field landing
- The restart procedure
- Declaring a 'Mayday' or 'Pan Pan' radio call

Specific Flying Objectives

Specific Flying Objective	Completed
Emergency field landing From a height above the ground of at least 1000ft, reduce engine power to idle. Select a suitable field for landing and fly an approach to land approximately 1/3 of the way into the field. Go around at a suitable height. This exercise is about setting up a correct approach.	Trained Consolidated Proved
Engine restart procedure and MAYDAY call From a height above the ground of at least 1500ft, reduce engine power to idle. After selecting a suitable field for landing demonstrate the restart procedure and MAYDAY call. Set up an approach for a forced landing and include forced landing checks.	Trained Consolidated Proved

Ex 7d: Navigation

Objective

To be able to safely navigate between two airfields without losing knowledge of the current position and land at different airfield.

Brief

- Pre-flight planning
- Flying the route
- Weather deterioration
- Unsure of position
- When you arrive

Specific Flying Objectives

Specific Flying Objective	Completed
Enroute navigation Plan and fly a route between a number of cross country turning points without getting lost and without the aid of a GPS unit. You should fly this exercise over unfamiliar territory. This exercise can be flown dual or solo.	Trained Consolidated Proved
Unfamiliar airfield circuits joins Plan and fly to an unfamiliar airfield correctly joining the circuit and land. If the airfield uses radio you must give appropriate radio calls. Obtain prior permission for landing (PPR) before flying. This exercise can be flown dual or solo.	Trained Consolidated Proved
Landing and take off on alternative surface Fly and land on a different landing surface from the one that you have used for your training. If you are used to grass, this exercise must be to a runway with a tarmac surface. If you are used to tarmac, this exercise must be to a runway with a grass surface. This exercise can be flown dual or solo.	Trained Consolidated Proved
Solo Cross country navigation Practice navigation in unfamiliar territory whilst solo.	Trained Consolidated Proved

Ex 7e: Qualifying Cross country

Objective

To perform the required cross country solo navigation exercises.

Brief

- Pre-requisites for cross country
- Plan the exercise
- The rules for a qualifying cross country flight

Specific Flying Objectives

Specific Flying Objective	Completed
Qualifying Cross Country No 1 Solo navigation with a landing at an airfield not less than 25 nm from the home airfield.	Trained Consolidated Proved
Qualifying Cross Country No 2 Solo navigation with a landing at an airfield not less than 25 nm from the airfield used for take off and different from the airfield and/or route in the first qualifying flight. This does not have to be a separate flight but can be an extension of Qualifying Cross Country No 1.	Trained Consolidated Proved

Section 8: General flying test

The `General Flying Test` is a flying exam, conducted by a CAA approved examiner to demonstrate safe handling of a Gyro. The aim of this test is to prove your competence at flying so that you will be entitled to the privilege to carry friends and family as passengers.

Ex 8a: Pre-GFT check

To prepare for the general flying test.

Ex 8b: General Flying Test

To show an examiner that you are safe and competent at flying a gyro and responsible to carry passengers.

Ex 8a: Pre-GFT check

Objective

To prepare for the general flying test.

Brief

- See brief for General Flying Test

Specific Flying Objectives

Specific Flying Objective	Completed
Flying Skills Check To repeat all the exercises signed off in this syllabus in preparation for the General Flying test.	Trained Consolidated Proved
Gyro daily inspection check Perform the routine daily inspection check of the Gyro, ideally using a checklist. Be able to answer questions on the components of a Gyro and possible component failures that may occur.	Trained Consolidated Proved
Performance considerations for the type of Gyro Answer questions relating to the type of Gyro being used for the test. Specifically weights and payloads, fuel weight and consumptions and min/max speeds, especially in turbulence.	Trained Consolidated Proved
Passenger safety brief Perform a safety brief for passengers. In particular exiting the Gyro in an emergency.	Trained Consolidated Proved

Ex 8b: General Flying Test

Objective

To show an examiner that you are safe and competent at flying a gyro and responsible to carry passengers.

Brief

- Daily Inspection
- Performance Considerations for Gyro type
- Passenger Safety Brief
- Selection of exercises for the skills test
- Nothing in the test should be new

Specific Flying Objectives

Specific Flying Objective	Completed
Gyro daily inspection check.	
Performance considerations for the type of Gyro.	
Passenger safety brief.	
Starting procedure : running up.	
Taxiing.	
Take-off and landing.	
Straight and level flying at pre-determined power settings and airspeeds, including at the lowest possible speed to maintain level flight.	
Climbing and descending turns.	
Recovery at a safe altitude from a point where forward speed has been reduced below the minimum speed for the maintenance of level flight by application of power.	
as above but recovery without application of power.	
Go-around from a baulked approach.	
Flight into and out of a restricted landing area, the landing to achieve the lowest possible touch-down speed consistent with safety.	
A power-off approach and landing, to touch down as near as possible to a selected point.	
Shut down procedure.	

Syllabus for the PPL(G)

2009 Edition

Part 2 - The Theory Elements

The PPL(G) Syllabus - The Theory Elements

Airfield Procedures

Every airfield should have their own local procedures. This section lists what procedures should be in place. For the safety of yourself and others, ensure that you have made yourself familiar with all these items during the early part of your training. There is no written examination for this topic.

Aviation Law, Flight Rules and Procedures

There are `rules of the air` for flying in the same way that there is a `highway code` for driving. Some of this relates to collision avoidance of other aircraft, all of it relates to your legal obligations as a pilot and the rules must be obeyed by law.

Gyroplane Technical

Understanding the terminology associated with Gyro flying should be important to every Gyro pilot. It is vital that you have a basic understanding of how and why a Gyro flies, as this will give you some element of knowledge in the event that something goes wrong whilst you are flying.

Meteorology

The weather plays a major role in flying. Weather is predictable and it is vital that, as a pilot, you can predict what is likely to happen during the course of your flight. Understanding the weather is a significant safety factor in flying.

Human Performance and Limitations

As a pilot, you have limitations. If you fly when you are outside these limitations there is a high chance of danger to you and your passengers. It is vital that you know about these limitations, recognise your own personal limitations and only fly within these limitations.

Navigation

Much of the fun of Gyros is visiting other places and other airfields. It is essential that you can navigate whilst in the air, both to avoid getting lost, but also to avoid putting yourself, your passengers and other aircraft in danger.

Airfield Procedures

Every airfield should have their own local procedures. This section lists what procedures should be in place. For the safety of yourself and others, ensure that you have made yourself familiar with all these items during the early part of your training. There is no written examination for this topic.

Airfield Procedures

- Standing Orders
- Booking In/Out
- Windsock
- Signals Square
- Manoeuvring areas

Safety

- Fire Extinguishers - location
- First Aid Kit - location
- Telephone - location
- Fuel Storage - suitable containers
- Smoking - nowhere near buildings or aircraft
- What to do in the event of an accident
- Refuelling
- Safety of onlookers

Flight Authorisation

- Preflight planning
- Aircraft documentation - service checks
- Certificate of Maintenance
- Air Traffic Units
- Personal Equipment (phone)
- Booking out
- Solo authorisation by instructor
- Daily Inspection

After flight

- Booking In
- Reporting Defects
- Personal Flying Logbooks
- Aircraft logbooks

Aviation Law, Flight Rules and Procedures

There are `rules of the air` for flying in the same way that there is a `highway code` for driving. Some of this relates to collision avoidance of other aircraft, all of it relates to your legal obligations as a pilot and the rules must be obeyed by law.

Aircraft Documents

- Registration Certificate
- Permit to fly
- Engine/Airframe/Prop Logbook
- Pilot operators handbook
- Maintenance Schedule
- Certificate of Maintenance
- Insurance Requirements

Aircraft Permit

- Limitations
- Revalidation
- Before flight checks
- Modifications

Personnel Licencing

- Privileges of a licence
- Revalidation period
- Medical requirements
- 90 day rule

Signalling

- Signals Square
- Marshaller Signals
- Light Signals

Flying Restrictions

- Charity
- Performing at an event
- Rule 5
- Events with more than 1000 people
- VFR Rules

Collision Avoidance

- Feature following
- Who has right of way in the air
- Who has right of way on landings
- Who has priority (different types of aircraft)

Flying

- Reportable accidents
- Alcohol limits
- When to use QFE/QNH/Flight Levels
- Danger Areas and restricted areas

Gyroplane Technical

Understanding the terminology associated with Gyro flying should be important to every Gyro pilot. It is vital that you have a basic understanding of how and why a Gyro flies, as this will give you some element of knowledge in the event that something goes wrong whilst you are flying.

Components of a Gyro

- Rotor
- Hub Bar
- Teeter Tower
- Teeter Block
- Teeter Bolt
- Roll Bolt
- Pitch Bolt
- Teeter Stops
- Mast
- Trim Spring
- Keel
- Main Wheels
- Nose Wheel
- Main Wheel Spar
- Empennage
- Rudder
- Horizontal Stabilser
- Vertical Stabiliser
- Nacelle
- Prerotator Gear
- Bendix Gear
- Prerotator Shaft

Controls

- How the stick works
- How the pedals work
- How the throttle works

Instruments

- ASI
- Altimeter
- Rotor RPM Gauge
- Engine RPM Gauge
- Oil Pressure

- Engine Temperate
- Engine Exhaust Gas Temperature

Electrical System

- Magnetos
- Master Switch
- Lights

Engine

- Fuel
- Oil
- Carb Icing

The forces acting on a Gyro

- Lift, weight, thrust and Drag

The rotor system

- Components of a rotor
- Autorotation and the forces on a rotor
- Disk loading on rotor rpm
- Dissymmetry of lift
- Flapping to Equality
- Reverse Flow
- Retreating blade stall
- Reducing stress on rotors

Stability

- The function of the empennage
- The need for pedal pressure when increasing power
- Centre of gravity calculation
- Propeller thrust and stability
- Rotor thrust and stability

Safety

- Height / Velocity diagram
- The Hang check

Meteorology

The weather plays a major role in flying. Weather is predictable and it is vital that, as a pilot, you can predict what is likely to happen during the course of your flight. Understanding the weather is a significant safety factor in flying.

Air Density

- What is air density
- How air density affects Gyro flying performance
- Factors affecting air density

ISA Definitions

- Pressure changes with height
- Temperature changes with height
- Lapse rates and stability
- Temperature Inversion

Air masses

- Air masses in the northern hemisphere
- Weather characteristics in air masses

Understanding synoptic charts

- Isobars
- Working out the wind direction from synoptic charts
- Warm fronts
- Cold fronts
- Occluded fronts

Wind

- Changes with height
- Wind gradient
- Turbulence over obstacles
- Wake Turbulence

Wind and hills

- Rotor turbulence
- Wave
- Orographic fog / cloud

Convection

- Sea Breeze
- Thermals
- Katabatic winds
- Anabatic winds

Fog

- Dew point
- Radiation fog
- Advection fog

Icing

- Different types of icing
- Factors affecting icing
- Consequences of icing on a Gyro

Cloud types

- Safe flying cloud types
- Clouds to be avoided
- Calculation of cloud base
- Rain & Squalls

Thunderstorms

- Conditions that cause thunderstorms
- How can you see thunderstorms approaching
- How far should you stay away from thunderstorms

Obtaining weather information

- TAFS
- METARS
- AIRMET
- 214
- 215
- When can you contact the met office

Flight planning and the weather

- Flying into weather

Human Performance and Limitations

As a pilot, you have limitations. If you fly when you are outside these limitations there is a high chance of danger to you and your passengers. It is vital that you know about these limitations, recognise your own personal limitations and only fly within these limitations.

Hypoxia

- Oxygen
- Signs and symptoms
- When it takes effect
- The effect of smoking

Hyperventilation

- Signs and symptoms
- Differences from Hypoxia

Flying with colds and flu

- What it effects

Scuba Diving

- The effects of decompression
- Recommended times between diving and flying

Stress

- Effects of stress on flying

Alcohol

- Effects of alcohol
- Elimination time
- Allowable volume

Lookout

- How to scan the horizon
- Collision times from flying speeds
- Flying with instructors / experience pilots

Air sickness

- Recognising the symptoms
- Medication
- Sickness in the air

IMSAFE

- Fit for flying

Navigation

Much of the fun of Gyros is visiting other places and other airfields. It is essential that you can navigate whilst in the air, both to avoid getting lost, but also to avoid putting yourself, your passengers and other aircraft in danger.

Reading aeronautical charts

- Understanding the 1/4mil map
- Understanding the 1/2mil map
- Limitations of maps
- Classification of airspace
- Danger and Restricted areas
- MATZ Transits
- Recognisable features

The route plan

- Working out a sensible route
- The route plan document
- Marking up a map
- Safety Altitude
- Flying speed

Calculating headings

- Using the whizz wheel
- Triangle of velocities
- Magnetic Variation and Isogonals
- Compass Deviation

Preparation for flight

- Fuel Consumption
- PPR
- Radio Frequencies

During flight

- Setting QFE / QNH
- Regional Pressure Settings
- Reading a map in flight

Certificate of Completion

Name of Student:

Date of birth:

Address:

The above student has been trained on all the elements of this syllabus.

The above student has had time and opportunity to consolidate this training and feels confident that he/she understands all of the exercises.

After the period of consolidation, all of the specific flying objectives have been demonstrated to the standard given in this syllabus.

Instructor

Name

Signed

Date

Licence No

Student

Signed

Date