BRITISH MICROLIGHT AIRCRAFT ASSOCIATION

TECHNICAL INFORMATION LEAFLET

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UNDERSTANDING AND USING PERFORMANCE DATA

1. Introduction

Every microlight aeroplane is supplied with an approved operators manual. In addition, much other information is available, such as airfield guides, TAFS and METARS, and once flying commences, the instruments fitted to an aeroplane. This guide has been written to help microlight pilots use this information to help them fly safely.

If you want more information on the subject, there is a reading list at the end.

2. Take-off Performance

2.1. Deciding whether to attempt a take-off ?

2.1.1. What information do I need?

Firstly don't go over the top with your planning; if you are planning to take-off from a 900m runway in a 912 engined flexwing, the answer is "yes, there's enough runway". What is important is that you know how to work out if it's safe to fly from a much shorter runway.

To make the decision about taking off from a small airfield, you will need the performance page from your microlights operators manual, and knowledge of the length, surface, and slope of your runway. It's also important to have some idea of the altitude (for our purposes, set an altimeter to 1013 hpa, and whatever it shows is your altitude), temperature, and surface wind.

A pocket calculator, or a pen and paper will also be needed.

2.1.2. How do I work out my take-off distance?

Firstly find the take-off distance given in the operators manual (if only one figure is given, this will be for MTOW – the worst case, some manuals may give values for different weights; if in doubt, use the MTOW figure). This will give the distance required to reach 50ft (15m) in height, at standard conditions. Then…

For every 1000ft you are above sea level	multiply by 1.1
For every 10°C above 15°C air temperature	multiply by 1.1
For every 2% of upslope	multiply by 1.1
If the ground is soft, or there is snow or wet grass	multiply by 1.25
if it is very soft (or wet) or the snow is more than 1" deep	multiply by 1.6
If you have to take-off with a tailwind	multiply by 1.2 for every 4 knots of wind
Now, to be sure, multiply by 1.33, to take into account that you may not fly the aeroplane as well as the company test pilot did when he worked out the values in the manual.	

The answer is the minimum amount of runway needed for a safe take-off.

2.1.3. Worked Example

- Let's say we are going flying two-up (and so near to MTOW) in a Pegasus XL-R with a 447 engine. According to the manual, this has a take-off distance of 180 metres. Let's say we want to take-off from Chilbolton airfield, which is 410m long, but the grass is wet.
- Due to a low pressure day, the altimeter reads 1000ft (when set to 1013), so we multiply 180m by 1.1, which makes 198m.
- It's summer, and 25°C, so we multiply 198m by 1.1, which makes 218m.
- Due to wet grass, we must multiply 218m by 1.25, which makes 272m.
- There's no wind today, so we don't adjust for it.
- Now for safety, we multiply by 272m by 1.33, which makes 362m.
- This tell us that we have enough runway, but only just. If however the runway had been 300m long then it would not be safe to fly today, even though the basic take-off distance in the manual is 180m.

3. Landing Performance

3.1. . Deciding whether to plan to land at a site?

3.1.1. What information do I need?

Firstly don't go over the top with your planning; if you are planning to land on a dry 850m runway at sea level in any microlight, there is probably no need to confirm that you can land there safely!

However, before planning a trip to an airfield with a short runway, you need to know the runway length, surface and slope [from an airfield guide], have some idea of the surface wind [by phone, from a METAR, or if all else fails, by radio from a bigger airfield nearby], and also be armed with the landing distance given in your operators manual.

3.2. How do I work out my landing distance?

Firstly take the value given in your operators manual (for the runway surface and flap setting that you'll be using), then…

For every 1000ft you are above sea level	multiply by 1.05
For every 10°C above 15°C air temperature	multiply by 1.05
For every 2% of downslope	multiply by 1.1
If the runway is tarmac or concrete	multiply by 1.2
If the ground is soft, or there is snow or wet grass	multiply by 1.25
If it is very soft (or wet) or the snow is more than 1" deep	multiply by 1.6
If you have to land with a tailwind	multiply by 1.2 for every 4 knots of wind
Now, to be sure, multiply by 1.43, to take into account that you may not fly the aeroplane as well as the company test pilot did when he worked out the values in the manual.	

3.3. Worked Example

Lets say we want to land at Clench Common airfield, which is at 650ft and is using runway 25, which is 350m long, we are in the middle of a heatwave and it's 35°C. This time we'll fly a Hornet R-ZA which has a landing distance of 199m, So…

- For altitude, multiply 199m x 1.0325 = 205m

  [1.0325 is equivalent to 1.05 per thousand feet: 5 x (625 / 1000) = 3.25]

- For temperature, multiply 205m x 1.05 x 1.05 = 226 m.
- Now multiply by 1.43 for safety, which makes 323 m.

In practice, this means that we can just afford to try and land at Clench Common, today; but, you need to be prepared to do a go-around if you haven't touched down early. It certainly might be worth a phone call to see if the longer 415m runway is available.

Also, it's important to bear in mind that the figure in the operators manual assumes that you "crossed the hedge" no higher than 15 metres (50ft), and so will be touching down reasonably early down the runway. If you are not confident of your ability to do so, then add at-least another 100m for safety – so a newly qualified pilot still struggling to land with great precision should perhaps reconsider aiming for a short runway like this.

4. Climb Performance

Most microlight manuals will quote a climb rate (at ISA sea level conditions) and a best climb speed. It is difficult to accurately predict how this will be affected by other factors, but in general…

- Surface temperatures hotter than 15°C will give a poorer climb rate. Colder temperatures will give a better climb rate.
- At speeds higher or lower than the best climb speed, the climb rate will be reduced. This is likely to be more pronounced at lower speeds (e.g. if the best climb speed is 45, then the aircraft should climb better at 50 than at 40). Reducing speed to try and improve the climb is rarely a good idea.
- In a low pressure, expect a reduced climb rate.
- Climb rate will reduce significantly at greater altitudes. So if you are climbing to clear cloud tops or mountain tops, climb early, not at the last minute.
- Climb rates will be better in a lightweight aircraft, and poorer in a heavy aircraft.

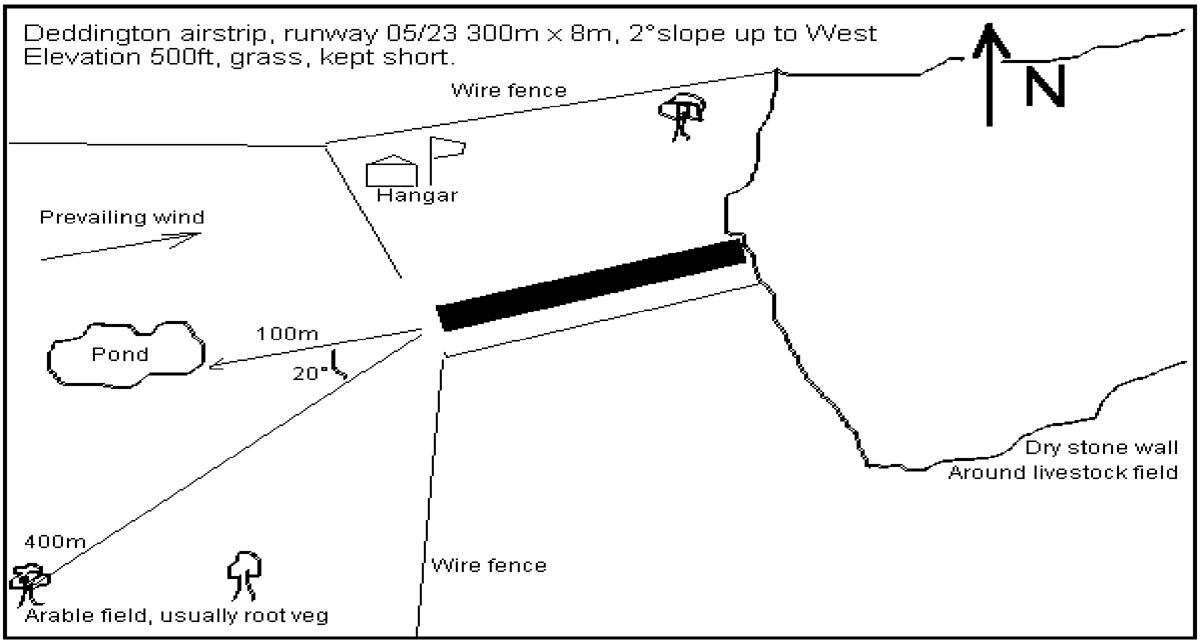
If you are going to be doing much flying in unusual conditions, and/or where climb rate is important, DO NOT RELY UPON THE VALUE IN THE MANUAL. Either apply very large safety factors, or (preferably) take the time before you need it to measure your aeroplanes own climb performance, at the conditions you will need to know your performance (of weight and pressure altitude, and if possible temperature). But even then safety factors should be applied – it is recommended that having determined the climb performance, you then assume that it will be half of what you have calculated.

One other point should be noted, which is that microlight VSIs are rarely very accurate – if you are trying to calculate an accurate climb rate, measure the time between two points on the altimeter.

5. Deciding whether a site is suitable for regular use

The calculations above apply to day-to-day flying. However, if you are deciding whether to use a field for regular flying, or perhaps deciding what is the right aeroplane for an flying school with a short runway, then some deeper thought is needed. There is no point in basing an aeroplane at an airfield either where you can't safely fly regularly, or where an engine failure on take-off would cause an immediate risk of accident.

Lets say the Deddington flying club is thinking of establishing Deddington Airstrip[1], where it will base a Pegasus CT2K and a Mainair Blade 912:-



The first important information is that we have a short grass runway, with a 2° upslope, 300m long. The next is the take-off and landing distances for the Blade and the CT, which are:-

Aircraft	Take-off distance (metres) to 50ft	Landing distance (metres) from 50ft, without brakes
Blade 912	140m	160m
CT2K	236m	275m

Runway length

Considering the Blade first, 140m x 1.05 (for altitude) x 1.1 (for slope) x 1.25 (for wet grass when it rains) x 1.33 (for safety) = 270m; so, in most normal conditions, the Blade should

[1] There isn't really a Deddington airfield, so please don't try to fly in to visit the BMAA.

have enough runway. This doesn't mean that pilots shouldn't do proper take-off calculations, only that most of the time the answer will be that it is safe to take-off.

But considering the CT, it needs 236m x 1.05 (for altitude) x 1.1 (for slope) x 1.25 (wet) x 1.33 (for safety) = 453m. In other words, this is not suitable for the CT and the Deddington flying club should either buy a 3-axis aeroplane with better short-field performance, or think about other measures (such as building a longer runway).

Using the same treatment on landing distances, we get figures of 293m for the Blade and 503m for the CT; which re-enforces the fact that this is not a suitable place to routinely fly the CT, and also highlights a need for special care if landing the Blade with moisture on the ground. As in previous examples, always remember that the landing distance in the manual assumes that the aircraft is no higher than 15m / 50ft when it crosses the runway threshold; precise flying is needed at short strips like this.

Clearway

Another issue in the selection of an airfield, which is sometimes forgotten is the need for a clearway. This is the area beyond the runway in which the aircraft can land in the event of an overrun or EFATO (engine failure after take-off). There should be at least the calculated landing distance of the aeroplane. This diagram shows only 100m of clearway on the extended centreline of RWY24, but with only a 20° turn, a full 400m is available after the runway – making the site safe for the Blade, but again the CT might not cope with an EFATO on this runway without hitting the trees in some conditions.

But, on the odd occasions that the wind blows from the East, the stone wall and field of livestock, change the picture completely. Anybody operating from this field must accept that with an Easterly wind, there is no clearway at all, which renders the airfield unsafe on these occasions, for either aircraft.

6. <u>Cruise Performance</u>

6.1. <u>Understanding your ASI and fuel gauge</u>

Whilst all pilot will understand the mechanics of an ASI, one thing it is important to know is that very few ASIs are truly accurate. So, if you are going to use the ASI to plan accurate long flights, you must know the corrections from IAS (Indicated Air Speed) to CAS (Calibrated Air Speed). Some aeroplane manuals will show these corrections, but others don't – if yours doesn't, BMAA TIL 027 tells you how to calculate the errors.

Microlights are usually blessed with very clear float or sight-tube type fuel gauges. However, to use it properly it should be calibrated – allowing you to know accurately how much fuel you have, or have used. Advice on how to do this is again in BMAA TIL 027 "Instrumentation and Avionics".

6.2. <u>Cruise performance data</u>

Unlike light aircraft, very few microlight manuals will give you accurate cruise performance data. But, it is very easy to measure. To do this, you need to fly straight and level, at a known speed, weight and heights, for long enough to be able to measure the amount of fuel used in a given time. If you can keep a couple of things constant (let's say you normally fly at about the same weight and trim speed), it's possible to plot a useable performance graph (in this case of fuel consumption per altitude). With a few tests, which can easily be recorded during normal flying activities, it's possible to generate a graph that will give you the cruise conditions throughout the conditions at which you normally fly.

There is no hard and fast rule about what should be fixed – do this to suit your aeroplane and your flying. For example, if you regularly fly an older generation flexwing under controlled airspace that starts at 2,500 ft – the best graph is probably one of fuel consumption against weight at 2,000 ft. On the other hand if you tend to fly lots of cross-countries in a 3-axis single seater, then weight is likely to be constant, so you might want to produce graphs of fuel consumption against cruise speeds at a range of heights.

For examples of data presentation, it is worth asking to see the operators manuals at a local light aircraft club – the most common will be Piper or Cessna manuals, which are both very clear, but have quite different approaches.

For more information on this subject, there are several references at the end of this TIL.

6.3. Using Cruise Data

Flight planning is part of the PPL syllabus, and it isn't the purpose of this TIL to replace proper instruction by a qualified instructor. However, sometimes a reminder can be useful. Shown below is a reminder about the use of cruise performance data, either from the operators manual or generated yourself, for accurate flight planning.

(a) Select cruise altitude and speed.

(b) Correct IAS to CAS, using data in the operators manual, or obtained as given in BMAA TIL 027.

(c) Correct CAS to TAS, using a density altitude correction (normally using a circular slide rule).

(d) Correct TAS to Ground Speed, by adjusting for wind (using either a circular slide rule or vector diagram)

(e) Using the fuel consumption calculated for that height, weight and speed, work out how much fuel will be needed for the cross-country segment.

(f) Add on reserves for taxiing, climbing, descending, the circuit, and diversions.

(g) Confirm that the aircraft will carry enough fuel for the trip.

7. Glide Performance

All microlight manuals quote an engine-out best glide speed, and a glide angle at that speed. Obviously, unlike other modes of flight, following an engine failure, careful planning is not a viable option and rules of thumb are the only thing that will be useful to a pilot.

The best glide speed is the speed at which you should fly, until a landing site is selected, and then it is not advisable to fly below it (unless the approach speed is below the best glide speed, which would be unusual). Dive-off or S-turn off excess height, don't allow the aircraft close to the stall.

The glide ratio will be quoted in the form "N:1", for example the Blade has a ratio of 9:1. This means that for every foot of descent at the best glide speed, the aircraft will travel forwards 9 feet. If the engine fails at low level, this is not particularly useful information, but at a reasonable altitude it allows calculation of whether it is possible to reach a known airfield or landing site. In still air, the following table offers a reasonable rule of thumb:-

Glide ratio	5:1	6:1	7:1	8:1	9:1	10:1	11:1	12:1	13:1	14:1
Range, nm, per 1000ft above circuit height	0.8	1.0	1.1	1.3	1.5	1.6	1.8	2.0	2.1	2.3

If you know in advance the figure, from this table, for your aeroplane (and also, the best glide speed if it isn't placarded), then you can quickly judge whether it's likely that you will be able to return to an airfield or if you have to land out.

But, these values are for still air; range will be reduced into wind and increased downwind. Again offering a rule of thumb (and note that this only applies to microlights, or aircraft with microlight performance), glide range will be increased by about $^1/_3$ nm, per 15 knots, per 1000 ft. Into wind or crosswind, it will be similarly reduced.

Worked example #1

Flying in a microlight with a 6:1 glide, you have an engine failure, at 3,500 ft, 5nm from an airfield which is downwind, wind is about 10 knots. Can you make it?

Assuming a 500ft circuit height, range is 1.0 x 3 = 3nm. 10 knots gives 0.2 nm per 1000ft = 0.6 nm extra range. So, you can glide 3.6 nm, you won't make it – pick a field !

Worked example #2

Flying in a microlight with a 12:1 glide, you have an engine failure at 6,000 ft, 7nm from a large airfield, which is into wind; wind is about 15 knots.

Assuming a 1000ft circuit height for a large airfield, 2.0 x 5 = 10nm. Subtract 5 x $^1/_3$ nm or 1.$^2/_3$, gives a glide range of 8. $^1/_3$ nm. You should be able to make it to land safely on the airfield.

8. <u>Further Sources of Information</u>

   8.1. **THE APPROVED OPERATORS MANUAL FOR THE AEROPLANE THAT <u>YOU</u> WILL BE FLYING.**

   8.2. CAA, General Aviation Safety Sense Leaflet 7B, Aeroplane Performance

   8.3. CAA, General Aviation Safety Sense Leaflet 3B, Winter Flying.

   8.4. AIC 12/1996 Pink 120, Take-off, climb, and landing performance of light aeroplanes.

   8.5. Trevor Thom, Air Pilots Manual Vol.4: The aeroplane: Technical, ISBN 1-840371552.

   8.6. Jeremy Pratt, The Private Pilots License Course Book 4: Technical, ISBN 1-874783810

   8.7. Martin Eshelby, Aircraft Performance, theory and practice. ISBN 0-340-75897 [Warning, this is quite heavy reading.]

   8.8. John Lowry, Performance of Light Aircraft. ISBN 1-56347-330-5. [Warning, this is also quite heavy reading.]

   8.9. If you want to produce accurate performance data for your aeroplane but are unsure how, consult a BMAA test pilot. The list of them is in BMAA TIL 023

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