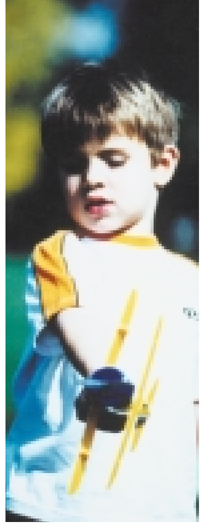
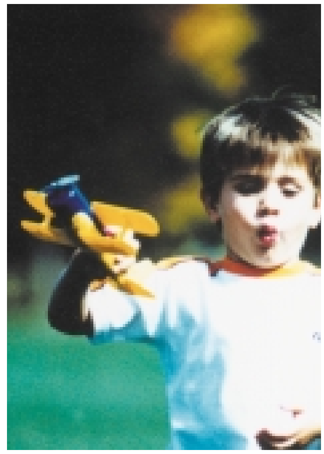
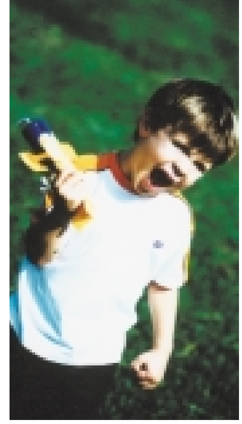
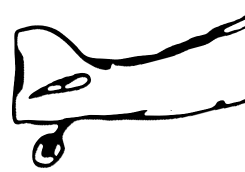
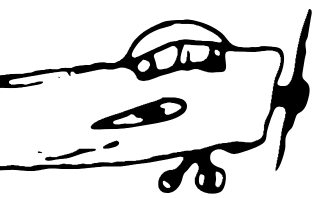


Running out of runway

Determining take-off and landing distance is child's play. Even so, pilots of light aircraft get caught out on short strips around the country every year – mostly because they didn't take the time to do some very basic pre-flight preparation.

By James Ostinga and Peter Goodhew

WHILE ATTEMPTING to take-off from a claypan on a station property, a Beech Musketeer failed to become airborne. After using all the available take-off run, the aircraft struck a tree and, still under full power, crashed into a dry creek. The aircraft was destroyed by fire and all four occupants were killed. The surface of the claypan from which the take-off was being attempted was a dry crust which crumbled under load, allowing the wheels to sink to some extent into the soft earth. At 360m, investigators found that the length of the claypan was hopelessly inadequate.

A student pilot and his instructor were practising a precautionary search at Kyneton ALA in a Cessna 172RG. The instructor asked the student to conduct a "touch and go" at the completion of the precautionary search. During the take-off roll of the touch and go the aircraft was not accelerating as the instructor anticipated. The instructor took control of the aircraft towards the end of the take-off roll and as the aircraft became airborne it struck a fence at the end of the runway. The aircraft climbed away, despite damage to the tailplane and undercarriage, and diverted to Essendon where the instructor completed a gear-up landing. If the student or instructor had contacted the aerodrome operator for permission to land they would have learned that the runway was unserviceable due to the softness of the surface caused by recent rain.

Both of these accidents could have been avoided if the pilots involved had had a greater understanding of the performance limitations of their aircraft.

Determining take-off and landing distance for light aircraft is not difficult, it just requires a basic understanding of performance charts and a little pre-flight planning.

Every take-off and landing must be preceded by a certain amount of planning and checking. The go/no-go decision properly begins with weather considerations, but there are a host of other factors, also critical to a safe flight, including a pre-flight inspection of the aeroplane and its systems, and the determination that the pilot is not only qualified for the task at hand, but physically and mentally fit as well.

Assuming that the aeroplane and the pilot are in all respects ready for flight, let's take a look at the factors that impinge upon an aeroplane as it takes off or lands.

Performance charts: A large part of your

PHOTOS: ROB FOX, JAMES OSTINGA. ILLUSTRATION THOMAS COVELL

success in getting on and off a runway, without causing harm to yourself, your aircraft or your passengers, will depend on your ability to use and fully understand take-off and landing performance charts.

Performance charts allow pilots to determine whether or not there is sufficient distance available, given a host of influential variables like wind direction and strength, aircraft weight, density altitude, surface type and slope.

However, not all performance charts are calculated the same way: some err on the side of safety and include a built-in margin for error, while others reflect the best performance you could hope to achieve in a new aeroplane, in ideal conditions.

Prior to 1990, all new aircraft with a maximum take-off weight less than 5,700kg were required to undergo a series of performance tests before being awarded Australian certification. These tests were used to produce uniquely Australian take-off and landing performance charts. These were published in the Australian Aircraft Flight Manual and were generally considered more accurate and more conservative than those published by manufacturers in Pilot's Operating Handbooks (POH).

There were several reasons for this. Prior to March 1978 the US FAA did not require take-off or landing distance information for aircraft with a maximum take-off weight less than 6,000lb (2724kg).

As a result, with many light aircraft there is no assurance that take-off and landing distances are determined in accordance with the appropriate airworthiness standards.

Similarly, data expansion is often carried out using excessively simple methods. Consequently, performance data may serve more to enhance the competitiveness of the type than to provide pilots with reliable information.

Furthermore, manufacturers' charts rarely allow for runway slope or surface type.

The take-off and landing distances demonstrated by an aeroplane manufacturer prior to certification are not typical of the distances achievable in service for a number of reasons. Usually, a manufacturer's measurement of runway performance is only carried out with:

- A new aeroplane with new engine, brakes and tyres.
- The airframe and propeller in newly manufactured condition.
- Highly experienced test pilots.
- Light wind conditions and negligible turbulence.
- Daylight and dry runway.
- Precise information about variables like aircraft weight, runway slope and wind.
- A steep approach to land at idle power.
- A minimum flare with very firm touchdown.
- Maximum braking commencing immediately after touchdown.

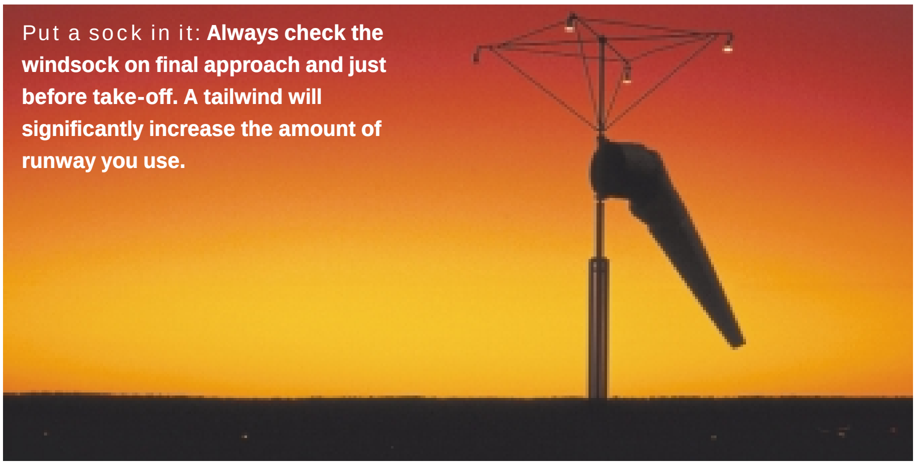
In contrast, take-off and landing in routine service can include many of the following:

- Deteriorated engine, brakes and tyres.
- Airframe and propeller with surface damage.
- Low-hour and low-currency pilots.
- Conditions of cross winds and strong turbulence.
- Night operations and wet runways.
- Approximate information about variables like aircraft weight, runway slope and wind.
- Threshold crossing heights greater than 50ft.
- Excessive speed crossing the threshold.
- Delays in reducing power to idle.
- Excessive float.
- Gentle flare and smooth touchdown.
- Less than maximum braking.

The result is a great scatter of the take-off

Good call: **If you plan to land on an unlicensed strip call the airfield or property owner before flying. If they give you permission to land they'll usually be happy to offer information about the strip. If the owner is not a pilot ask for the number of a pilot who uses the strip.**

PHOTO: ROB FOX.

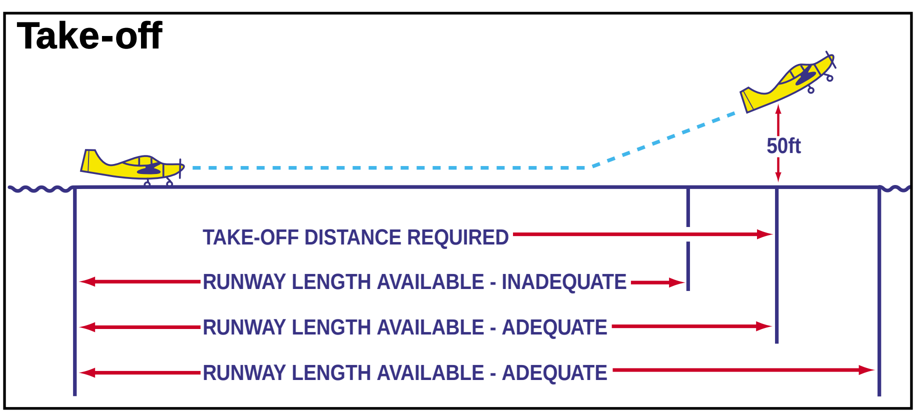


Put a sock in it: **Always check the windsock on final approach and just before take-off. A tailwind will significantly increase the amount of runway you use.**

PHOTO: ROB FOX.

Nail the speed: **Short-field approaches are all about energy management. Too fast and you'll burn up too much runway. Too slow and you could stall.**

PHOTO: ROB FOX.



UK CAA, AIC 12/96.

and landing distances achieved in routine service.

Australian performance charts allowed for this by multiplying demonstrated take-off distances by a factor of 1.15 to 1.25 (increasing with aircraft weight), and multiplying demonstrated landing distances by a factor of between 1.15 and 1.43.

Despite the greater accuracy, consistency and tolerance of the Australian charts, their production ceased in 1990. There were several reasons for this including:

• The large cost and inconvenience to manufacturers, importers, operators and pilots.
• The fact that many light aircraft require such small distances to take-off and land that most licensed aerodromes are entirely adequate, irrespective of factors like weight, density altitude and approach speed.

However, problems can arise at shorter unlicensed aerodromes, especially when the pilot is unaware that manufacturers' performance charts do not include a safety margin.

Consider a Cessna 172N taking off from a paved level runway at 5,000ft pressure altitude, with a temperature of 25°C in nil wind conditions. At a take-off weight of 950kg the Australian performance chart indicates the aircraft would require 900m to take-off and climb to 50ft. In contrast, the manufacturer's chart suggests the same take-off can be made in just 590m (65 per cent of the distance specified by the corresponding Australian chart.) Similar discrepancies exist with most light aircraft.

The solution: The information in the pilot's operating handbook (POH) is entirely adequate as long as you understand that no safety factors have been built in. An allowance must be made for the fact that operators' figures will likely be difficult, if not impossible, to duplicate in real-world conditions.

A good starting point is to apply the safety factors used in Australian performance charts. For take-off, in aircraft with a maximum take-off weight (MTOW) of 5,700kg or less, these are:

• 1.15 for aeroplanes with maximum take-off weights of 2,000kg or less.
• 1.25 for aeroplanes with maximum take-off weights of 3,500kg or greater.
• For aeroplanes with maximum take-off weights between 2,000 kg and 3,500kg, a factor derived by linear interpolation between 1.15 and 1.25 according to the maximum take-off weight of the aeroplane.

For landing, in aircraft with a maximum

take-off weight (MTOW) of 5,700kg or less, the safety factors are:

- 1.15 for aeroplanes with maximum take-off weights of 2000kg or less;
- 1.43 for aeroplanes with maximum take-off weights of 4500kg or greater;
- For aeroplanes with maximum take-off weights between 2000kg and 4500kg, a factor derived by linear interpolation between 1.15 and 1.43 according to the maximum take-off weight of the aeroplane."

Additional factors should also be applied in cases when the performance chart does not allow for the effects of runway slope and surface type.

The table on the following page offers a guide to the effects of different variables on aircraft performance. These factors are cumulative and where several factors are relevant they must be multiplied.

Back to the Cessna 172N. Imagine the same take-off but on a short wet grass runway that slopes uphill by 2%. Allowing for an overall safety factor, and further factors to accommodate the surface and slope, the minimum take-off distance required increases from 590m to 970m (590m x 1.1 [slope] x 1.3 [wet grass] x 1.15 [overall safety factor]).

Depending on your experience, currency, and familiarity with the aircraft and runway, it may be prudent to multiply that distance by another factor to further increase your margin of safety.

In its publication "Take-off and landing performance" the NZ Civil Aviation Authority advises:

"Even after having worked out your aircraft's take-off or landing performance, it is prudent to add a contingency to allow for other factors that you may have overlooked. For instance, the engine may not be performing as well as it used to, the brakes may be dragging slightly, the propeller may be less efficient than it used to be or you might encounter a lull or shift in the wind.

"Where take-off and landing distances are looking marginal, we suggest you always factor a contingency of at least 10 per cent into your calculations."

Short-field ops: All the calculations in the world won't help you if your short-field technique is poor.

While all private pilots are required to demonstrate proficiency in short field operations, the reality is that most pilots go on to operate from runways never less than 1000m and quickly forget these skills.

A walk in the park: **The best way to estimate the length of a strip is to pace it out. Always plan to clear any obstacles on the climb-out path by at least 50ft.**

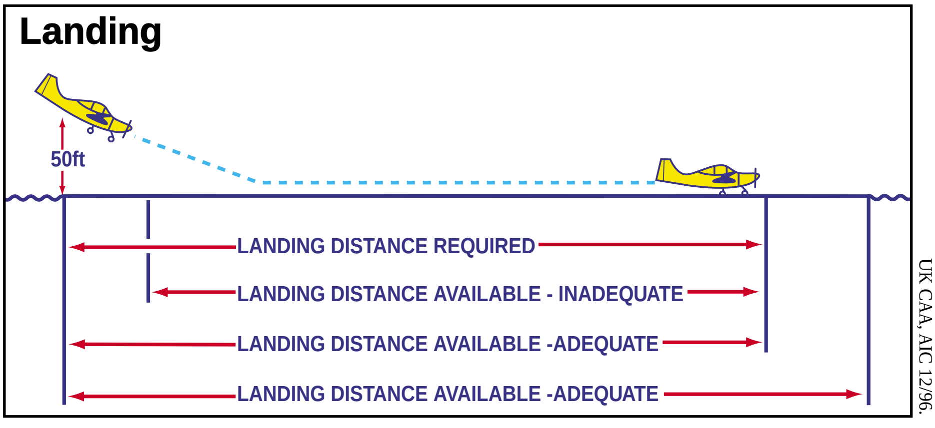
PHOTO: ROB FOX.

Up or down? **Wind and obstacles permitting, take-off downhill and land uphill.**

PHOTO: ROB FOX.

By the book: **Follow the manufacturer's recommendations for short-field take-offs and landings. Improvised techniques will eventually end in tears.**

PHOTO: ROB FOX.



UK CAA, AIC 12/96.

Before flying anywhere near a short field it's important to review your technique.

Landing: Short-field approaches are all about energy management. Anyone can fly fast. Manoeuvring comfortably and safely at slow speed requires a little more skill. If you're not able to maintain a target speed to within a few knots on approach you're not ready for short-field landings. Track down an instructor and start practising.

It's also important to closely follow the flying techniques recommended by the manufacturer for short-field approach and landing. For example, the Cessna 172N POH recommends the following:

- Airspeed: 65-70KIAS (flaps up).
- Wing flaps: full down (40°).
- Airspeed: 60 KIAS (until flare).
- Trim: adjust.
- Power: reduce to idle after clearing obstacle.
- Touchdown: main wheels first.
- Brakes: apply heavily.
- Wing flaps: retract.

If you don't follow the recommended technique, you can't hope to achieve anything approaching best short-field performance.

Landing distance required should always be based on the distance needed to bring the aeroplane to a complete stop from the point where the aeroplane first reaches a height of 50ft above the landing surface.

Take-off: Always refer to the operating handbook for the correct departure configuration and technique. Remember, it is in the manufacturer's best interests to tell you how to get the most out of your aeroplane. Always be wary of improvised techniques that aren't recommended by the manufacturer.

Every time you plan a take-off, select a decision point along the runway where you will still be able to safely stop the aircraft if acceleration does not meet expectations.

If runway length is an issue, it is important that you line up at the very beginning of the runway. If things go wrong, a few metres may be the difference between a near-miss and a disaster.

The speed at which you lift off and climb to 50ft is also important. Be guided by the POH: a few knots above or below the recommended rotate and best-angle-of-climb speed can greatly extend your take-off distance.

Plan to clear any trees, wires, or other obstacles on the climb-out path by at least 50ft. To do this you will need to work out your aircraft's climb gradient when you make your take-off performance calculations. Climb gradient can be calculated by dividing the aircraft's known rate-of-climb by the number of nautical miles covered in one minute. So, if you expect to climb at 500fpm and your climb speed is 60kts (or 1nm per minute), you will climb 500ft for every nautical mile covered (or 50ft per 0.1nm).

When in doubt: Many pilots commit to memory the take-off and landing distances required for their aircraft on a sealed level runway, in nil-wind, ISA conditions at sea level. This gives them a rough idea of when they need to consult the performance charts.

Halfway through the landing or take-off roll is no time to find out you don't have enough runway.

Peter Goodhew is a Brisbane-based chief flying instructor.

Performance factors for light aircraft

Take-off

Condition	Increase in take-off distance to height 50ft	Factor
A 10% increase in aeroplane weight	20%	1.2
An increase of 1,000ft in airfield altitude	10%	1.1
An increase of 10°C in ambient temperature	10%	1.1
Dry grass – up to 20cm (on firm soil)*	20%	1.2
Wet grass – up to 20cm (on firm soil)*	30%	1.3
A 2% uphill slope*	10%	1.1
A tailwind component of 10% of lift-off speed	20%	1.2
Soft ground or snow*	25% or more	1.25+

Landing

Condition	Increase in landing distance from height 50ft	Factor
A 10% increase in aeroplane weight	10%	1.1
An increase of 1,000ft in airfield altitude	5%	1.05
An increase of 10°C in ambient temperature	5%	1.05
Dry grass – up to 20cm (on firm soil)*	20% or more	1.2+
Wet grass – up to 20cm (on firm soil)*⁺	30% or more	1.3+
A 2% downhill slope*	10%	1.1
A tailwind component of 10% of landing speed	20%	1.2
Snow*	25% or more	1.25+

**Effect on ground run/roll will be greater.*
⁺When the grass is very short, the surface may be slippery and distances may increase by up to 60% (a factor of 1.6).

1. These factors are cumulative and where several factors are relevant they must be multiplied.

2. Any deviation from normal operating techniques is likely to result in an increase in the distance required.

3. Where a manufacturer specifies a particular factor which is greater than any of those listed, the manufacturer's advice should take precedence.

Adapted from the from the UK Civil Aviation Authority document: "Take-off, climb and landing performance of light aeroplanes" (AIC 12/96).