

# Take-off and landing performance

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# Contents

<b>PIC responsibilities</b> .....	5	<b>Determining performance</b> .....	20
How to comply .....	5	Group rating system .....	20
<b>Performance factors</b> .....	6	P-charts.....	22
Weight .....	6	Aircraft Flight Manual.....	30
Air density.....	6	Air transport operations .....	32
Wind.....	10	Know your aircraft.....	33
Slope .....	12	<b>Conclusion</b> .....	34
Surface.....	12	Performance questions .....	35
Obstacle clearance .....	13		
Flap setting .....	14		
Ground effect.....	14		
Wing surface .....	16		
Tyre pressure .....	16		
<b>Other considerations</b> .....	17		
Runway distance .....	17		
Pilot technique.....	17		
Speed control .....	18		
Decision points .....	18		
Contingencies .....	19		

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Every effort is made to ensure the information in this booklet is accurate and up-to-date at the time of publishing. But numerous changes can occur with time, especially in regard to airspace and legislation. Readers are reminded to get appropriate up-to-date information.

A significant number of accidents and incidents occur during take-off and landing. Ensuring that your take-off and landing can be conducted within the confines of the runway will significantly contribute to the safety of these critical phases of flight.





# PIC responsibilities

Civil Aviation Rules clearly indicate that it is the responsibility of the pilot in command to ensure that they operate their aircraft in a safe manner with respect to take-off and landing performance. In particular, rule 91.201(2) states that “A pilot-in-command of an aircraft must... during the flight, ensure the safe operation of the aircraft and the safety of its occupants...”.

## How to comply

If you are operating under Part 91, Advisory Circular 91-3 *Aeroplane Performance Under Part 91* provides guidance on how best to comply with rule 91.201(2). Essentially, AC91-3 says that you can determine the take-off and landing performance of your aircraft by one of the following three methods:

- Group Rating system;
- P-charts; or
- Approved Aircraft Flight Manual data.

AC 91-3 also provides performance correction tables for surface type, slope, and contaminated runway surfaces, since this information is often omitted from many light aircraft Flight Manuals.

If you are operating under Part 135, there will be specific performance requirements you will need to meet – these are briefly discussed later in this booklet.

Note that the group rating system, for instance, is quite conservative and sometimes shows that an aircraft will not fit on to a particular runway when in fact P-chart calculations (which are more precise) show otherwise. It is quite acceptable to select the method that shows that the operation can be performed within the aircraft’s performance limits.

All of these three methods are discussed, with worked examples, later in this booklet.

# Performance factors

Many different factors affect aircraft performance.

## Weight

The gross weight of the aircraft directly affects stall speed, a 10 percent increase in weight increasing the stall speed by 5 percent.

### *Take-off*

Lift-off speed is generally about 15 percent above the stalling speed, so an increase in weight will mean a higher lift-off speed.

In addition to the higher speed required, acceleration of the heavier aeroplane is slower. Hence, a longer take-off distance will be required. As a general rule of thumb, a 10 percent increase in take-off weight has the effect of increasing the take-off run by about 20 percent.

### *Landing*

Heavier landing weights require higher approach speeds, which means the aircraft will have greater momentum and require more runway in which to land and stop.

A 10 percent increase in landing weight has the effect of increasing the landing distance by about 10 percent.

## Air density

As air density decreases, both engine and aerodynamic performance decrease.

### *Effect of pressure on density*

Atmospheric pressure decreases with altitude, because the air near the earth's surface is compressed by the air above it. As altitude increases, air is free to expand and therefore becomes less dense.

### *Effect of temperature on density*

Temperature generally also decreases with altitude. This causes the air to contract and become denser. However, the drop in pressure as altitude is increased has the dominating effect on density when compared with the effect of temperature.

### *Effect of humidity on density*

Water vapour is lighter than air; consequently moist air is lighter than dry air. It is lightest (or least dense) when, in a given set of conditions, it contains the maximum amount of water vapour.

## International standard atmosphere

A *standard atmosphere* has been established to enable comparison of aircraft performances, calibration of altimeters and other practical uses.

In the International Standard Atmosphere a particular pressure and temperature distribution with height is assumed.

At sea level the pressure is taken to be 1013.2 hPa and the temperature 15°C.

In this 'average' atmosphere, any pressure level has a standard corresponding altitude called the *pressure altitude* (based on a lapse rate of approximately one hPa per 30 feet at lower levels) and a corresponding temperature called the ISA temperature. Pressure altitude is the height that will register on a sensitive altimeter whenever its sub-scale is set to 1013.2 hPa.

In the standard atmosphere, temperature falls off with height at a rate of 1.98°C per 1000 feet up to 36,090 feet, above which it is assumed to be constant (see Figure 1).

Warm air is less dense than cold air.

Thus, when the temperature at any altitude in the atmosphere is higher than the temperature would be in the standard atmosphere at the same altitude, then the air at that altitude will be less dense than in the standard atmosphere.

ISA also assumes dry air. In normal conditions, the amount of water vapour in the air does not make a significant difference to its density. However, as warm air can contain much more water vapour than cold air, at high temperatures and high humidity, the reduction in density may become significant and degrade aircraft take-off performance accordingly.

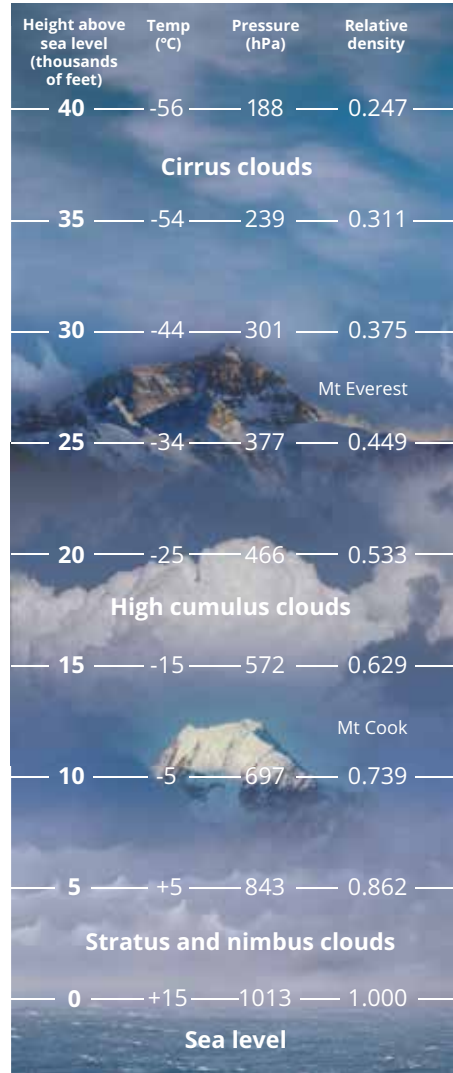


Figure 1: The international standard atmosphere

## Density altitude

*Density altitude* represents the combined effect of pressure altitude and temperature.

It is defined as the height in the standard atmosphere, which has a density corresponding to the density at the particular location (on the ground or in the air) at which the density altitude is being measured.

Aircraft performance depends on air density, which directly affects lift and drag, engine power, and propeller efficiency. As air density decreases, aircraft performance decreases. Density altitude, therefore, provides a basis for relating air density to ISA, so that aircraft performance can be readily determined.

Density altitude can be calculated by taking pressure altitude and adding (or subtracting) 120 feet for each 1°C above (or below) ISA.

When an aircraft is taking off at a density altitude above ISA sea level, it will still get airborne at the same indicated airspeed as at sea level, but because of the lower density the true airspeed (TAS) will be greater. To achieve this higher speed with the same engine power, a longer take-off run will be needed.

The effect of a high density altitude on the power developed from the unsupercharged engine is adverse, and less power will be available for take-off. (When taking off from a high density altitude aerodrome, the engine will not even develop the power it is capable of unless the mixture is correctly leaned.)





An increase in density altitude, therefore, has a twofold effect on the take-off:

- An increased take-off speed (TAS) is required.
- Engine power and propeller efficiency are reduced.

The approximate effect of these two components on take-off and landing performance are:

- The take-off distance is increased by one percent for every 100 feet of aerodrome pressure altitude above sea level, and the landing distance by one percent for every 400 feet.
- The take-off distance is increased by one percent for every 1°C above the standard temperature for the aerodrome elevation.
- Rate-of-climb and angle-of-climb are noticeably reduced, as is obstacle clearance after take-off.

High density altitudes are found most commonly at high-elevation aerodromes when the temperature is high.

Low atmospheric pressures will accentuate the effect. Taking off with a heavy aeroplane in these conditions is fraught with danger. Your take-off performance sums have got to be right.



## Wind

### Headwind

Taking off into wind results in the shortest take-off run and the lowest groundspeed on liftoff. If it becomes necessary to abandon the take-off, not only will the lower groundspeed make it easier to stop, but also the shorter take-off run means more runway available to do so. Climbing into wind gives a lower groundspeed and therefore a steeper angle of climb after take-off; this is good for obstacle clearance.

Landing into wind results in a lower groundspeed and shorter landing run.

Take-off and landing distances are reduced by about 1.50 percent for each knot of headwind up to 20 knots.

### Tailwind

Taking off downwind results in a much longer distance to get airborne and a decreased angle of climb, which is bad for obstacle clearance.

For a 5-knot tailwind component, the take-off distance should be multiplied by 1.25, and for 10 knots, by 1.55.

Landing distances are similarly increased.

Tailwind take-offs and landings should be avoided unless it can be established with absolute certainty that there is sufficient distance available to do so.

### Crosswind

A crosswind situation will affect take-off and landing performance, mainly because of the reduced headwind component.

If the wind is 30 degrees off the runway heading, the headwind is effectively reduced by 15 percent. If the wind is 45 degrees off, the headwind is reduced by 30 percent.

### Gusting winds

A gusting wind situation will require that you keep the aeroplane on the ground for a slightly longer period of time to provide a better margin above the stall, thereby increasing your overall take-off roll.

Gusty conditions also necessitate a higher approach speed, which results in a longer landing roll.

### Turbulence and windshear

The possibility of turbulence and windshear should be considered when working out take-off or landing distances. Windshear is a change in wind velocity (speed and/or direction) over a very short distance.

The presence of windshear can cause sudden fluctuations in airspeed after take-off or during an approach.

Hangars, buildings and areas of trees all influence the flow of the wind near them. The mechanical turbulence resulting from this disturbed airflow may become very marked in the lee of the obstruction.

In winds below 15 knots, turbulence occurs in the lee of the obstruction and may extend vertically to about one third higher again than the obstruction.

In winds above 20 knots, eddies can occur on the leeward side to a distance of about 10 to 15 times the obstruction height and up to twice the obstruction height above the ground.



## Slope

An uphill slope increases the take-off ground run, and a downhill slope increases the landing ground run. For example, an upslope of 2 percent increases take-off distance by about 15 percent and a 2 percent downslope decreases it by about 10 percent.

Slopes can be calculated from known or estimated information. Divide the difference in height between the two strip ends by the strip length (working in the same units of measurement). For example, 15 metres (50 feet) height difference on a 750-metre strip gives an answer of 0.02, or a 2 percent slope.

## Surface

### *Take-off*

Grass, soft ground or snow increase the rolling resistance and therefore the take-off ground run will be longer than on a sealed or paved runway.

Dry grass can increase take-off distance by up to 15 percent. Long wet grass can further increase this distance depending on the length and wetness of the grass and the weight and wheel size of the aircraft. Aircraft type is a big factor here – attempting to take off on such a surface in a Piper Cub is an entirely different proposition to a Cessna 172 for example.



It is often inadvisable to take off in long wet grass, and it can be impossible.

Puddles of water on the runway can also significantly retard acceleration.

### *Landing*

On landing, grass or snow cause an increased ground roll, despite increased rolling resistance, because the brakes are less effective.

Long wet grass can mean a very large increase in the landing run due to this effect.

### **Obstacle clearance**

Plan to clear obstacles on the climbout path by at least 50 feet.

Consider what your aircraft's climb gradient is likely to be as part of your take-off performance calculations – especially if terrain, wires, and the possibility of downdraughts are factors in the climbout path. Calculating the gain-of-height per mile is straightforward. Simply divide the aircraft's known rate-of-climb performance by the number of nautical miles covered per minute eg, 500 fpm/1.1 NM per min = 454 feet per NM of climb performance (this assumes a groundspeed of 66 knots).

This will then give you a good indication of whether you will be able to maintain safe terrain and obstacle clearance.



## Flap setting

Flap reduces the stalling speed and enables you to lift off at a lower indicated airspeed. This can mean a shorter ground run, but it may not give any reduction in take-off distance to 50 feet because flap usually causes a reduction in the rate of climb.

The recommended flap setting should always be used.

## Ground effect

When flying close to the ground, the wing generates less induced drag than a wing out of ground effect. Thus the wing is more efficient while in ground effect.

While this can be useful on occasions, it can also trap the unwary into expecting greater climb performance than the aeroplane is capable of sustaining.

On landing, ground effect may produce 'floating' and result in a go-around (or an overrun, if the danger signs are ignored) particularly at very fast approach speeds.



Low-wing aeroplanes are more sensitive to ground effect than high-wing ones.


Ground effect makes it possible to lift off at too high a pitch angle, or too soon with a heavy load. Taking off too steeply (or too soon) will cause the angle of attack to be at or near that of a stall, with drag and thrust nearly equal, and thus no chance of accelerating.

Don't force your aircraft to become airborne too soon.

Let it lift off when it's ready to fly. Utilise ground effect by briefly holding the aircraft

in ground effect to let it accelerate to best angle-of-climb speed before climbing out. This is especially important when departing from a short soft field with obstacles.

If you inadvertently leave ground effect too soon, and the aeroplane is not able to accelerate to its proper climb speed, the only way to retrieve the situation is to lower the nose, allow the aircraft to accelerate, and then climb. The problem is, that you may not be able to achieve satisfactory obstacle clearance as result, which is all the more reason for making sure that you get it right first time.

A photograph of a low-wing aircraft, possibly a Cessna, on a grassy airfield. The aircraft is positioned on the left side of the frame, with its wings extending towards the right. The background features a line of trees and a range of mountains under a cloudy sky. The overall scene is a typical rural airfield setting.

// Consider what your aircraft's climb gradient is likely to be as part of your take-off performance calculations – especially if terrain, wires, and the possibility of downdraughts are factors in the climbout path. //



### **Wing surface**

Deposits on the wing surface, such as raindrops or insects, can have a significant effect on laminar flow aerofoils such as used on some self-launching motor gliders and high-performance home-built aeroplanes. Stall speeds are increased and greater distances are required.

The presence of surface frost, ice or snow affects any aerofoil, including the propeller. Minor hangar rash or dents on the lifting surfaces or propeller will also degrade performance. Keep all lifting surfaces damage-free and clean to ensure maximum performance.

### **Tyre pressure**

Low tyre pressure (perhaps hidden by grass or spats) will increase the take-off run.

This is something that should always be checked during the pre-flight walk around.



# Other considerations

It is good airmanship to think about what technique, speed, and decision point, you will use for every take-off and landing.

## Runway distance

Information on available runway distances is published in the *AIP New Zealand AD* section.

At non-published airstrips, distances should be paced out. Pace length should be established accurately – or deliberately underestimated.

If you expect to use a strip frequently, you should ensure that the length is measured accurately (for example, by using a rope of known length).

## Pilot technique

Ensure that recommended short-field take-off and landing techniques are always used when operating out of airstrips where the distance available is a factor. Consult the Flight Manual, or an instructor, if you are unsure as to what technique should be used for a particular aircraft. Consider undertaking some dual short-field take-off and landing revision.



## Speed control

The speed at which you lift off is very important with regard to achieving the best take-off performance from the aircraft – particularly when runway length is a significant factor. Likewise, letting the aircraft accelerate in ground effect to best angle-of-climb speed is also critical.

For landing, correct speeds for the prevailing conditions are obviously important.

Arrive too fast and you will use up more runway, too slow on approach and you may stall and not arrive on the runway at all.

## Decision points

You should always nominate a decision point where you will abandon the take-off or discontinue the approach if things are not going as expected.

For take-off, this is the point at which there is sufficient distance available to safely stop the aircraft should it accelerate slower than expected or suffer a power loss. This is particularly important for multi-engine aircraft.



For landing, the decision point should be a height where there is sufficient room to effect a safe go-around if you are not happy with the approach. An important factor here, and one that is often overlooked by pilots, is the assessment of groundspeed while on approach. A check of the windssock and an estimate of whether your ground-speed is about what you would expect for your airspeed when on short final is good practice. Any tailwind component very significantly increases the landing distance, so a go-around is usually the best course of action should this be the case.

## Contingencies

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, you might encounter a lull or shift in the wind, etc.

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





## Determining performance

The following section gives three ways of ensuring adequate take-off and landing performance for private operations.

### Group rating system

#### *What is it?*

Every light aircraft in New Zealand has been (and still is) assigned a group rating number from 1 to 8 – based on its take-off and landing performance at maximum weight (1 = excellent performance and 8 = poor performance). Runways that are published in the *AIP New Zealand* AD section are also assigned a group rating number based on their characteristics (1 = short distance available and 8 = long distance available).

The Group Rating system allows for runway length, slope and surface, with a generous allowance for ambient conditions, and it assumes that the operation is conducted

into wind using recommended short-field techniques. The system can't take into account specific conditions on the day, so the aircraft Group Rating number allocated is conservative for private operations. However, if ambient conditions differ significantly from ISA in a way that will reduce performance, and the airstrip is sloping, it would be wise to use a P-chart or the Flight Manual to determine take-off and landing distances.

The group number of your aircraft can be found in the front of its Flight Manual. The runway group rating number can be found in the table at the top of each aerodrome operational data page in the *AIP New Zealand* AD section.

### How does it work?

Using the group rating system is very simple. For example, if your aircraft has a group rating of 6, it is safe to operate from runways with a group rating of 6 or greater. If the runway group rating is less than 6 it may still be safe to operate under favourable conditions, but you would need to work out the distances required for the prevailing conditions using one of the other two methods.

Note that some runways may in fact have more than one group number assigned to them because of differences in the available take-off and landing distance, for example Gisborne (see Figure 2).

AIP New Zealand						NZGS AD 2 - 52.1						
Certificated Aerodrome 1NM W of Gisborne						<b>GISBORNE</b>						
NZGS						<b>Not for operational use</b> OPERATIONAL DATA (1)						
<b>RWY</b>												
RWY	SFC	Strength	Gp	Slope	ASDA	Take-off distance						LDG DIST
						1:20	1:25	1:30	1:40	1:50	1:62.5	
14 32	B	PCN 20 F/B/Y/T	8	0.07U 0.07D	1310					1371	1371 1270	1310
14 14	B	PCN 20 F/B/Y/T	7 6	0.07U		777	EXTENSION CLOSED					868
32 32	B	PCN 20 F/B/Y/T	6 7	0.07D		868	EXTENSION CLOSED					777
14 14	Gr	ESWL 1600	4 6	0.08U		551						750
32 32	Gr	ESWL 1600	6 4	0.08D		750						551
03 21	Gr	ESWL 5700	8	0.05U 0.05D		1042 1170						1170 1042
09 27	Gr	ESWL 9080	8	0.1U 0.1D		1039 1173						1173 1039

Figure 2

## P-charts

Use of a Performance chart (P-chart) is another acceptable method (which is more precise than the group rating system) for determining take-off and landing performance.

### *What are they?*

P-charts are graphs developed from manufacturers' test data. They apply various factors, including density altitude, type of operation, runway surface, runway slope and

wind to readily determine take-off and landing distances for a particular set of conditions.

The CAA no longer (as of 1 April 1997) includes a P-chart when it issues a Flight Manual for an aircraft. But for the majority of light aircraft in New Zealand the P-chart remains a very practical method of determining take-off and landing performance and can be completed with ease. If your aircraft Flight Manual has a P-chart, it is important to know how to use it and to understand what is being allowed for.



// If your aircraft Flight Manual has a P-chart, it is important to know how to use it and to understand what is being allowed for. //



## Examples

The following example gives guidance on how to best use a P-chart. (Note that at the bottom of the P-chart there is a tracking depiction on how to work from box to box.)

### Take-off distance example

The red line in Figure 3 relates to the data supplied below and the blue line provides a comparison for 'standard' conditions.

Note that all take-off distances are to a height of 50 feet, at which point a speed of  $1.2 V_s$  (where  $V_s$  is the stall speed for the chosen configuration) is assumed to have been achieved. Landing distances are also all from a height of 50 feet with a speed of  $1.3 V_s$  when passing through that height. The distances given for private operations represent the minimum distance acceptable, and pilots should carefully review all factors (and other options) before landing at or taking off from an aerodrome with only the bare minimum distance available.

*Type of Operation – Private*

*Aircraft – Cessna 172P*

*Max all up weight – 1089 kg*

*QNH – 997 hPa*

*Temperature – 26°C*

*Wind – 050°M/15 knots*

*Aerodrome elevation – 1320 feet amsl*

*Runway – 020°M*

*Surface – grass*

*Length – 730 metres*

*Slope – 1% up*

### Determining density altitude

The first thing we need to do is to calculate the airstrip's density altitude.

To do this we must determine the pressure altitude of the airstrip and then correct it for temperature by using the ambient temperature of the day (26°C in this case). This is an area that many pilots seem to have difficulty with.

The easiest way to determine pressure altitude, if we are sitting in our aircraft, is to set the sub-scale on the altimeter to 1013.2 hPa. The altimeter will then read the pressure altitude of the aerodrome.

Alternatively, knowing that 1013.2 hPa is ISA pressure at sea level, we calculate the difference from today's QNH (sea level pressure), which is 997 hPa. This is 16 hPa below 1013.2 hPa, and as each hectopascal equals approximately 30 feet, this equates to 480 feet. We must now apply this correcting figure to our aerodrome elevation of 1320 feet. Do we add it or subtract it?

Because the pressure today is lower than standard (pressure decreases with altitude, 997 hPa being found at 480 feet amsl on a standard day) we add the figure to aerodrome elevation, arriving at a pressure altitude of 1800 feet.



# TAKE-OFF

This graph incorporates CASO 4 factors and corrections and gives the take-off distance to a height of 50 feet.

CESSNA 172P

ENGINE: Avco Lycoming O-320-D2J

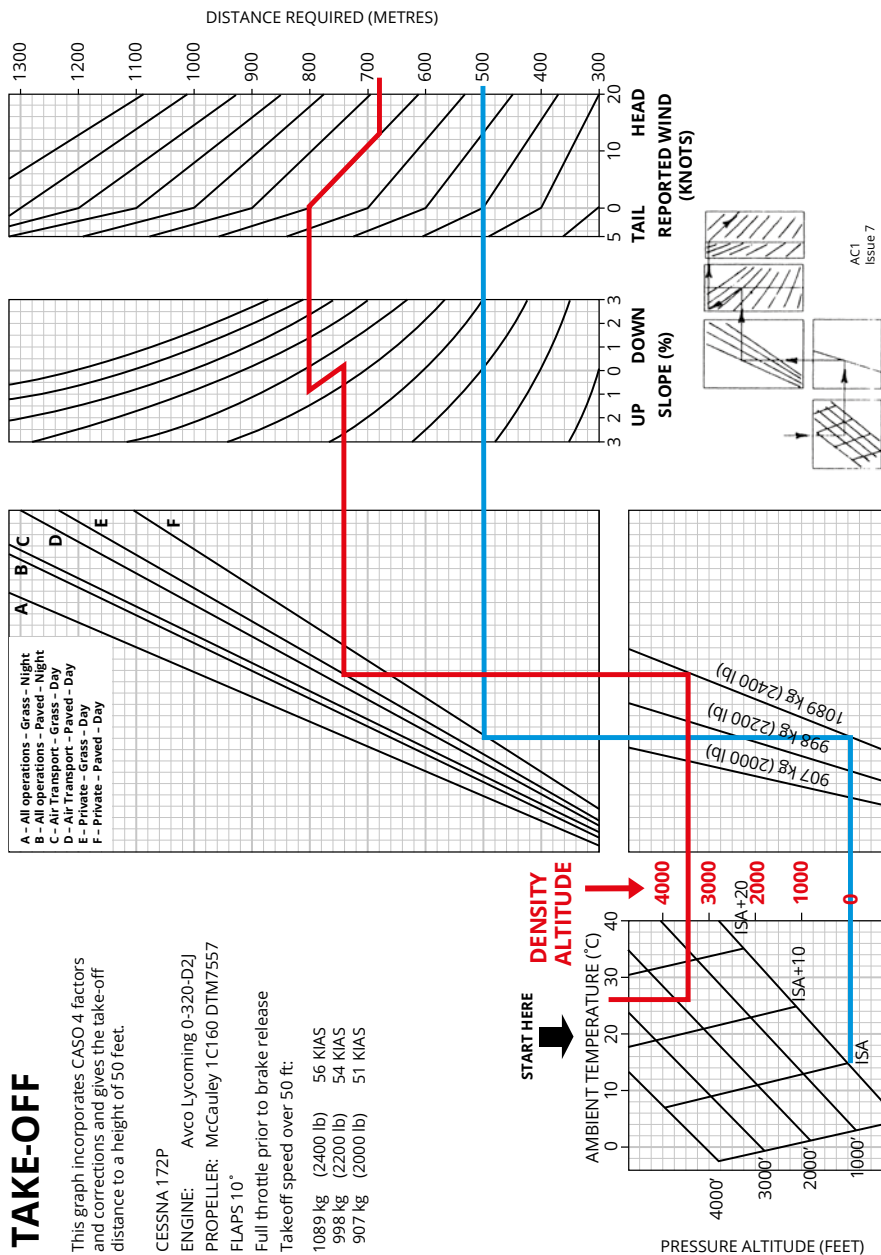
PROPELLER: McCauley 1C160 DTM7557

FLAPS 10°

Full throttle prior to brake release

Takeoff speed over 50 ft:

- 1089 kg (2400 lb) 56 KIAS
- 998 kg (2200 lb) 54 KIAS
- 907 kg (2000 lb) 51 KIAS



ACI Issue 7

Figure 3

### *Density altitude graph*

Now we start at the box for determining density altitude which can be found at the bottom left of the chart. We enter the graph at the top with the ambient temperature of 26°C, and track vertically down that line until we meet the imaginary angled pressure altitude line for 1800 feet (ie, a point just under the angled 2000-foot line).

(For our exercise, we don't need to worry about the angled temperature lines marked "ISA+10" etc, which depict the ISA drop-off in temperature with altitude.)

From that point we exit the box horizontally to the right. A scale is not usually marked on the right-hand side of the box, but we have shown the density altitude figures in colour on our example to give you a better appreciation of what you are working out. (You will note that, although the aerodrome elevation in our example is only 1320 feet, the density altitude under the prevailing conditions is 3500 feet – quite a significant difference.)

### *Weight*

Continue horizontally into the next box until we meet the weight line of 1089 kilograms (ie, the maximum). You will notice that the only variable on the chart that the pilot has any control over is the weight of the aircraft. Bearing this in mind, the graphs can be used to work out a safe operating weight on marginal runways.

### *Surface*

From this point we track vertically up into the next box, until we meet the line "Private – Grass – Day".

### *Slope*

We then move horizontally to the next box going through to the zero line. (This is most important – always go to the zero line in the last two boxes.) We then track parallel to the curved lines until we reach the 1 percent up line.

### *Wind*

The headwind component must now be determined because the wind is not straight down the runway. The crosswind component graph in the Flight Manual can be used to calculate this (see figure 4). The headwind component in this case is 13 knots.

Now we move horizontally to the zero line of the wind box. Using the headwind component of 13 knots track parallel to the curved line until we reach the 13-knot headwind line. From this point, we exit horizontally to the right of the box, where we can read off the distance required for take-off.

In this example nearly 700 metres is required to reach a height of 50 feet. As the runway in this example is 730 metres long, we should be able to take off safely (but remember this is for short dry grass).

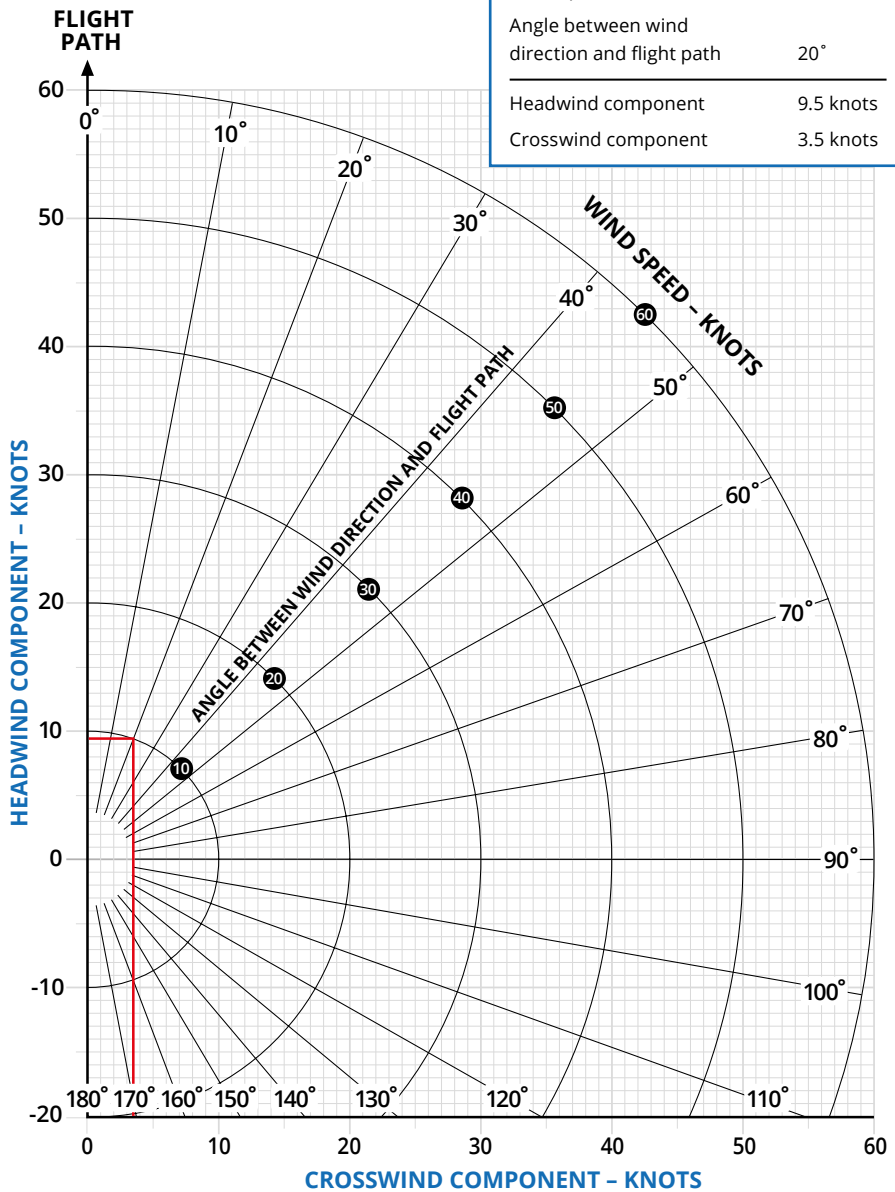


Figure 4: Wind components

### *Landing distance example*

Now work through the landing example provided (see Figure 5) using the same aircraft, aerodrome and weather conditions as above by following the red line.

Note that aerodrome elevation is used rather than density altitude in this calculation, as engine performance is not a critical factor (unless a go-around becomes necessary).

At very high density altitudes, however, the resulting higher true airspeed (TAS) should be borne in mind in relation to the approach and landing, as should the reduced power available for a go-around.

You will also note that the slope corrections are reversed from the take-off situation; an uphill slope on landing will decrease the landing distance and vice versa.



# LANDING (TRICYCLE LANDING GEAR)

This graph incorporates CASO 4 factors and corrections and gives the landing distance from a height of 50 feet.

CESSNA 172P

FLAPS 30°

Power off

Maximum braking

Approach speed over 50 ft:

1089 kg (2400 lb) 61 KIAS

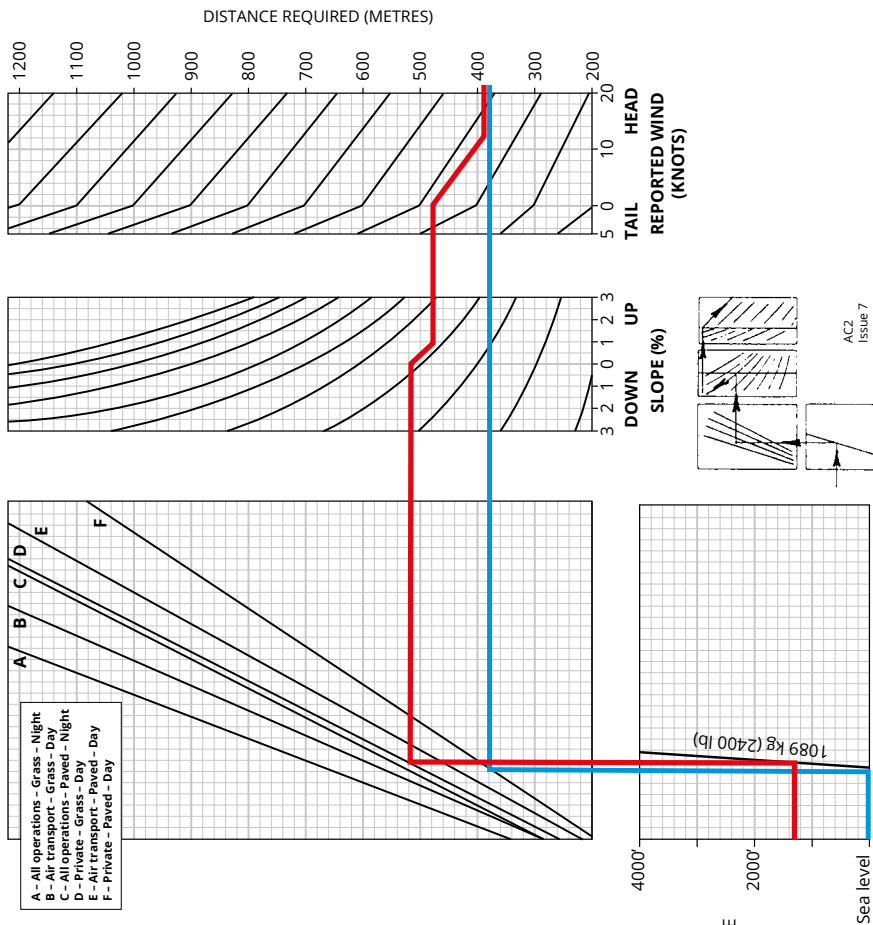


Figure 5



## Aircraft Flight Manual

Take-off and landing performance graphs/tables in aircraft Flight Manuals vary from manufacturer to manufacturer.

Usually they do not allow for as many variables as P-charts.

Each graph or table will normally be formulated for standard conditions (ie a level, dry, paved surface in nil wind with the aircraft configured for a short-field take-off or landing) and allows for variations in weight, pressure altitude, and temperature only. For tables, these variables are usually given over rather a broad range, eg temperature in bands of 10°C and pressure altitude in bands of 1000 feet. Other variables, such as wind and type of surface, have to be allowed for manually and added to the basic take-off or landing distance as a percentage value.

AC91-3 suggests that take-off and landing distances derived from the aircraft flight manual should be corrected for variation in runway surface and slope by applying the factors in Figures 6 and 7.

If your aircraft Flight Manual has a P-chart, we suggest that, in most cases, it is preferable that you use it over other Flight Manual data – particularly if it is an old Flight Manual, some of which tend to be less comprehensive than their modern counterparts. Some manufacturers' Flight Manual data can also, at times, tend to be optimistic rather than conservative about their aircraft's performance.



**Figure 6:**  
Runway surface factors

Surface type	Take-off distance factor	Landing distance factor
<b>Paved</b>	x 1.00	x 1.00
<b>Coral</b>	x 1.00	x 1.05
<b>Metal</b>	x 1.05	x 1.08
<b>Rolled earth</b>	x 1.08	x 1.16
<b>Grass</b>	x 1.14	x 1.18

**Figure 7:**  
Runway slope factors

Direction of slope	% of slope	Take-off distance correction	Landing distance correction
<b>Uphill</b>	1	+5%	-5%
	2	+10%	-10%
	3	+15%	-15%
<b>Downhill</b>	1	-5%	+5%
	2	-10%	+10%
	3	-15%	+15%

## Air transport operations

If you are operating a light aircraft on Air Transport or Commercial Transport operations, there are specific performance requirements that must be met in CAR Part 135 *Air Operations – Helicopters and Small Aeroplanes*, Subpart D.

For example, the take-off distance required must not exceed 85 percent of the take-off run available. You must take account of not more

than 50 percent of the reported headwind (or not less than 150 percent of the reported tailwind, as the case may be). There are also specific runway surface and slope correction factors to apply.

Part 135 requires you to use Flight Manual data to determine take-off and landing performance. This may include the use of P-charts but the group rating system is not acceptable for air transport operations.





See Advisory Circular 119-3 *Air Operator Certification – Part 135 Operations* for details on how to compile a P-chart and apply the applicable Air Transport factors to your aircraft Flight Manual performance data.

### **Know your aircraft**

It is useful to work out, and remember, the take-off and landing distances required for your aircraft in ISA conditions at sea level, with nil slope, and nil wind on a sealed runway.

This can serve as a basis for determining whether it is necessary to carry out performance calculations in any given situation. Always err on the side of caution when it comes to deciding whether such calculations are necessary – it is better to be safe than sorry.

If you own your own aircraft, you might like to consider actually confirming what distance it will take off and land in under these conditions – get to know your own aircraft.





## Conclusion

Take-off and landing are both high-risk phases of flight. The more that we can do as pilots to minimise these risks, especially when operating out of a short airstrip in an underpowered aircraft, the safer we will be.

If take-off or landing performance is ever doubtful, then taking the time to apply basic performance calculations is a prudent thing to do and takes the 'she'll be right' out of the situation.

Make performance calculations part of your pre-flight planning if you suspect things might be tight.

## Performance questions

Now that you have seen how to use a P-chart, try these problems by using the chart provided in the original example above (answers below).

1. A private flight, C172P, aircraft weight 1089 kg, QNH 1020 hPa, temperature 20°C, aerodrome elevation 400 feet, slope nil, grass/day, wind 250° M at 5 knots, runway 22.

What take-off and landing distances are required?

2. An air transport flight, C172P, aircraft weight 1089 kg, QNH 997 hPa, temperature 26°C, aerodrome elevation 1700 feet, slope 1 percent down, paved/day, wind 150° M at 10 knots, runway 18 (520 metres).

Can I safely land on runway 18 in these conditions?

3. I would like to fly into Kaikoura (elevation 19 feet), which has a Group 4 grass runway, in my private Group 6 Cessna 172P. Assume standard pressure, a temperature of 25°C, and nil wind. The runway is 575 metres long with no slope.

What would be the maximum allowable weight for a safe take-off under these conditions? Could I land there at this weight?

4. A private flight, C172P, aircraft weight 2400 lbs, QNH 1013 hPa, temperature 25°C, aerodrome elevation 1000 feet, nil slope, grass/day, wind 220° M at 10 knots, runway 22.

Use the Flight Manual data provided below, and any other corrective factors required, to calculate the take-off distance to 50 feet under these conditions.

Answers to aircraft performance problems:

1. Take-off – 570 metres.
- Landing – 460 metres.
2. Yes – 460 metres would be required.
3. Maximum weight would be 1045 kg. Yes, I could land there at this weight.
4. 1973 feet is required.

Weight LBS	Take-off speed KIAS		Press alt ft	0°C		10°C		20°C		30°C	
	Lift off	At 50 ft		Ground roll ft	Total ft to clear 50 ft OBS	Ground roll ft	Total ft to clear 50 ft OBS	Ground roll ft	Total ft to clear 50 ft OBS	Ground roll ft	Total ft to clear 50 ft OBS
2400	51	56	S.L.	795	1460	860	1570	925	1685	995	1810
			1000	875	1605	940	1725	1015	1860	1090	2000
			2000	960	1770	1035	1910	1115	2060	1200	2220
			3000	1055	1960	1140	2120	1230	2295	1325	2480
			4000	1165	2185	1260	2365	1355	2570	1465	2790
			5000	1285	2445	1390	2660	1500	2895	1620	3160
			6000	1425	2755	1540	3015	1665	3300	1800	3620
			7000	1580	3140	1710	3450	1850	3805	2000	4220
8000	1755	3615	1905	4015	2060	4480	---	---			

- Notes:**
1. Decrease distances 10 percent for each 9 knots of headwind.
  2. For operation on a dry, grass runway, increase distances by 15 percent.

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**Good Aviation Practice**

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See the CAA website for Civil Aviation Rules, advisory circulars, airworthiness directives, forms, and more safety publications.

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*Take-off and landing performance*  
was revised in February 2020.