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LIGHT AIRCRAFT OPERATING TIPS

Canada

3rd edition (revised 1988)
Cat. No. T52-63/1986E
ISBN 0-662-15151-8

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Introduction

This booklet has been published as a general guide for pilots flying light aircraft. Convenient rules of thumb on takeoff, landing and flight performance are provided to augment the authorized data contained in the aircraft flight manual. These operating tips are drawn from a wide variety of experienced sources, and provide additional guidance that will increase the safety of flying operations.

The information provided is not intended to replace the aircraft flight manuals, training publications, or the manufacturers' recommendations. The performance charts in the aircraft flight manual and the recommended procedures of the manufacturer are the authoritative source on aircraft performance.

Light Aircraft Operating Tips is a useful, pocket-sized guide for light aircraft pilots.

Operations from Unimproved Strips

Takeoff performance charts in aircraft flight manuals are based on dry, hard-surfaced runways. On occasion you may fly from an unimproved runway of turf, grass, gravel, mud or snow. The following estimates are a guide to the additional takeoff distance required based on runway surface:

Surface:

a. firm turf	add	7%
b. rough surface, short grass	add	10%
c. long grass (over 4 inches)	add at least	30%
d. soft mud, snow, etc.	add at least	75%

Flight from soft mud or snow surfaces requires a high degree of pilot judgment and skill, and should be avoided unless absolutely necessary.

Runway Slope:

In many cases the precise runway slope will be unknown. It is important to remember that 1° of upslope adds about 10% to your takeoff roll, whereas 1° of downslope reduces the roll by only 5%. A larger upslope in excess of 2° will add quite significantly to takeoff distances. Keep in mind that sloping runways provide a different visual perspective than a level surface, and takeoffs and landings on sloped runways demand more planning and closer attention to flying technique.

If a takeoff must be made on an upsloping runway, it is important to know if the aircraft can climb safely away from rising terrain. Uphill takeoffs with tail winds should be avoided. If a takeoff is commenced downhill with a tail wind, the aircraft will accelerate more rapidly. At high density altitudes the rolling speed may be more pronounced. Avoid the temptation to lift off prematurely because the groundspeed seems high. Do not rotate until you have a safe indicated airspeed.

Corrections For Density Altitude and Aircraft Weight

Add 10% to your aircraft takeoff distance for every 1,000 foot increase in density altitude. At density altitudes above 3,000 feet, and up to and including 6,000 feet, add 20% per 1,000 foot increase.

Decreasing the aircraft takeoff weight by 10% will decrease the takeoff roll by 10%. Increasing the takeoff weight by 10%, however, may add 20% to the takeoff roll, depending on how the manufacturer has calculated the aircraft V_{LOF} (velocity at liftoff). A conservative adjustment of 10% for decreasing weight and 20% for increasing weight should allow an adequate reserve for most types of light aircraft, whether the V_{LOF} is variable with weight or remains constant.

Headwinds and Tailwinds

The following simple formulae provide a rough adjustment for the effect of a headwind or tailwind on takeoff performance. They should not be applied to headwinds less than 10 knots, or tailwinds greater than 5 knots. Remember that your aircraft may have a tailwind as well as a crosswind limitation. Takeoffs with tailwinds greater than 10 knots are not recommended. Consult your aircraft flight manual for exact information.

Headwind:

$$90\% - \left(\frac{\text{headwind component}}{\text{rotation speed}}\right)\% = \text{(T/O ground roll) \% or (\% of distance to clear 50' obstacle)}$$

Tailwind:

$$110\% + \left(\frac{\text{tailwind component}}{\text{rotation speed}}\right)\% = \text{(T/O ground roll) \% or (\% of distance to clear 50' obstacle)}$$

Applying the above formulae to a 10 knot headwind or 5 knot tailwind, and an aircraft rotation speed of 50 knots, provides the following changes in takeoff distance:

Headwind e.g.:

$$90\% - \left(\frac{10\text{ kt}}{50\text{ kt}}\right)\% = 90\% - 20\% = 70\%$$

Ground roll 1,200 feet × 70% = 840 feet with 10 kt headwind

Tailwind e.g.:

$$110\% + \left(\frac{5\text{ kt}}{50\text{ kt}}\right)\% = 110\% + 10\% = 120\%$$

Ground roll 1,200 feet × 120% = 1,440 feet with 5 kt tailwind

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Combined Effect of Density Altitude, Weight, Surface and Slope

The effects of changes to aircraft weight, runway surface and slope, and density altitude can combine to dramatically increase takeoff distances. For example, an aircraft weighing 2,000 pounds at sea level has an 800 foot ground roll in still air on a hard-surfaced runway. That same aircraft will take 1,647 feet to get airborne in the following conditions:

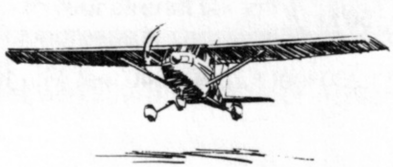
1. Density altitude: 2,000 feet (add 20%)
2. Aircraft takeoff weight increased 10%: (add 20%)
3. Long grass, firm surface: (add 30%)
4. 1° upslope: (add 10%)

800′ + 20% = 960′
960′ + 20% = 1,152′
1,152′ + 30% = 1,497′
1,497′ + 10% = 1,647′

Takeoff Distance Over a 50 Foot Obstacle

Your aircraft flight manual will provide information for takeoff distance to clear a 50 foot obstacle. If the same 2,000 pound aircraft requires 1,500 feet on hard-surfaced runways to clear a 50 foot obstacle at sea level, similar adjustments will have to be made in our example to correct for density altitude, weight, surface and slope.

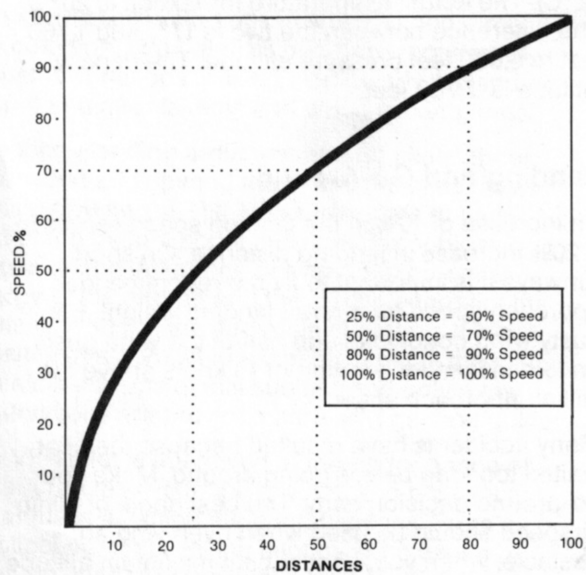
1,500′ + 20% = 1,800′
1,800′ + 20% = 2,160′
2,160′ + 30% of 1,152′ = 2,505′
2,505′ + 10% of 1,497′ = 2,655′



Estimating Acceleration and Runway Remaining

Light aircraft often operate off shorter runways that do not provide full accelerate-stop distances (that is, the distance required to gain flying speed, experience and recognize an engine failure, abort the takeoff roll, and stop on the remaining runway). As a general rule, accelerate-stop distances for light aircraft are between 2 and 2½ times the takeoff ground roll.

A light aircraft pilot can calculate an estimate of speed attained versus runway used as a helpful guide to takeoff performance. The chart below outlines the relationship between takeoff speed and runway distance used. The chart assumes a hard-surfaced concrete or asphalt runway, and additional adjustments must be made for unprepared runways. It is based on the following formula: the square root of the percentage of liftoff distance required, multiplied by 10 and rounded off, equals the percentage of liftoff speed that should be attained in that distance.



You should be able to reach liftoff speed within the first 75% of useable runway. If you can't meet this rule, reduce the aircraft takeoff weight, or delay the takeoff until winds and density altitudes are more favourable.

Density Altitude – By Computer, Koch Chart, or Math

A hand held electronic calculator or circular flight data computer is useful for computing the exact density altitude. The Koch Chart in the Canada Flight Supplement can be used to calculate the takeoff distance, using the actual temperatures and altitudes. As an alternative method, the following mathematical calculations can be applied:

a. The sea level International Standard Atmosphere (ISA) temperature is 15° Centigrade. Subtract the standard lapse rate of 2° Centigrade per 1,000 feet of altitude. This calculation provides the standard ISA temperature for your pressure altitude.

b. Compare the standard temperature against the actual temperature. For each 10° difference above ISA, add 1,000 feet to the pressure altitude to obtain density altitude.

Example:

Pressure altitude is 6,000 feet. The standard ISA temperature at 6,000 feet is 3°C (15°C minus 12°C). The actual temperature for takeoff is 20°C. The difference between the two is 17°. Add 1,700 feet to 6,000 feet pressure altitude. The density altitude is 7,700 feet.

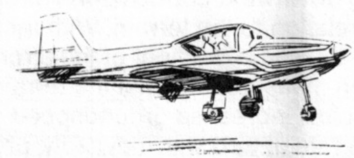
Landing and Go-Around

An increase of 10% in the landing speed results in a 20% increase in landing distance. On short runways it is important to fly the recommended approach speed for aircraft landing weight. For gusty wind conditions add half of the wind gusts up to a maximum addition of 10 knots above the still air approach speed.

Many accidents have resulted because the pilot waited too long before going around. Make your go-around decision early. The best angle of climb airspeed should be used when overflying an obstacle, when you want to gain maximum altitude in a minimum distance. The best rate of climb airspeed should be used when you want to gain the maximum altitude in the minimum amount of time.

Know the best angle of climb and best rate of climb speeds for your aircraft. Do not let your IAS decrease below your go-around speed, since this will reduce aircraft performance. Follow the manufacturers' recommendations regarding the use of flaps on go-arounds.

In hilly terrain the visual horizon may be misleading. Flying an accurate climb speed will avoid an excessively nose-high altitude.



The Effect of Wind During Downwind and Upwind Turns

Rarely in flying do winds remain constant in direction and speed. Variations in strength and direction are common. Light aircraft pilots are required to adjust to variations in wind, particularly on landing, during and after takeoff, and when making turns.

The long standing argument among pilots about downwind and upwind turns, and the effect of wind turning downwind, still arises from time to time. Part of the debate about this complex subject hinges on the difference between the potential energy of the aircraft and the kinetic energy of the airmass in which the aircraft is operating. It is not possible in a booklet to examine in detail the many technical aspects of this subject, and only a few observations are provided here as a general guide.

The VFR pilot is interested in the performance of the aircraft relative to the ground, and not simply to the airmass in which the aircraft moves. From a practical perspective, the pilot must be aware of what the wind is doing, and how the wind effect will look from the cockpit.

In an aircraft turning downwind, an increase in groundspeed is inevitable. This creates the illusion of increased airspeed. No change in airspeed occurs due to headwinds or tailwinds, but groundspeed is definitely changed, and changes in drift over the ground can be quite marked. An aircraft flying at 100 knots IAS in a 20 knot headwind will have a groundspeed of 80 knots. Following a 180° turn, the same aircraft with the same airspeed will now have a groundspeed of 120 knots. This is a 50% increase in groundspeed and will be quite noticeable from the cockpit.

A pilot may increase the angle of bank to correct for the increasing drift in the downwind turn, and inadvertently stall the aircraft. Another potential risk of turning downwind concerns the aircraft's flight path in relation to the terrain. With increased groundspeed the climb gradient of the aircraft will be flatter when measured against the terrain and ground obstacles. Increased groundspeed with no change in the rate of turn will, inevitably, produce a larger radius of turn. Understandably, a pilot turning downwind in narrow valleys, or in an area of significant obstacles, could get in trouble.

As an example, an aircraft flying in a 20 knot headwind at 70 knots IAS performs a steep turn through 180°, using a rate 3 turn (9° per second). The aircraft will drift downwind 200 metres (656 feet) by the time the 180° turn is completed.

A simple rule-of-thumb to estimate the amount of drift in metres when turning from a headwind into a tailwind, or when flying a 360° turn, is to multiply the time to turn in seconds by half the windspeed in knots. The calculations and diagram below illustrate the effect:

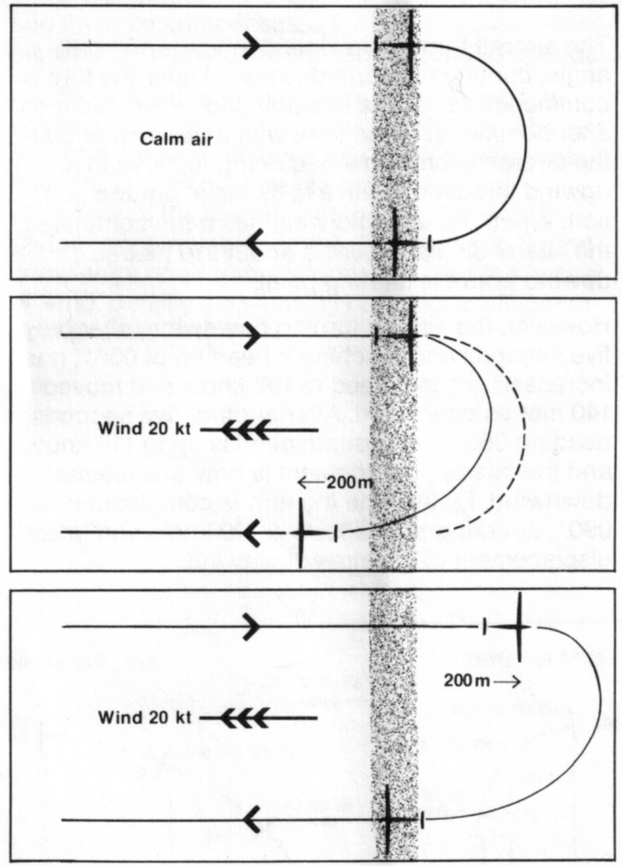
Rate of turn = 9° / second
Degrees of turn = 180°
Time to turn = 180° divided by 9° = 20 seconds

Therefore, downwind drift is 20 seconds × 10 knots, or 200 metres.

In the example of a rate 1 turn (3° per second) through 360° in a 30 knot wind, the drift is quite significant:

Drift downwind = 120 seconds × 15 knots = 1,800 m. (5,906 feet)

The diagram below illustrates the position of an aircraft over the ground in calm wind through a 180° turn (top figure), in a 20 knot wind with no drift correction (middle figure), and the adjustment required (bottom figure) to arrive at the same position on the ground after the 180° turn.

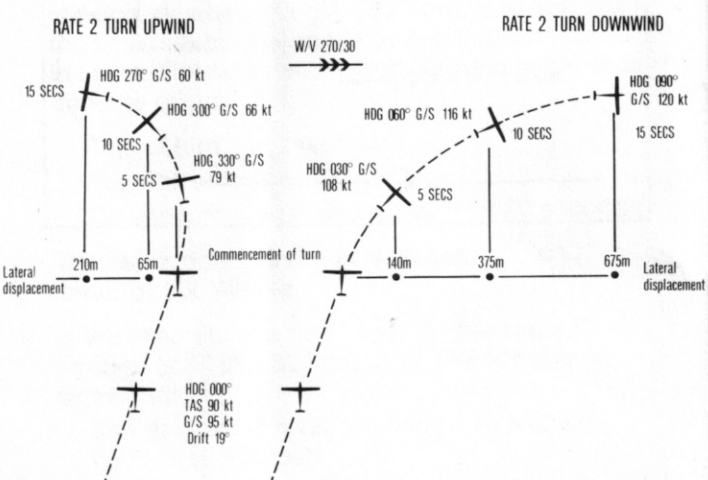


The Effect of Drift During Turns

The diagram below illustrates the dramatic difference in drift turning downwind and upwind, using a Rate 2 turn (6° per second). With a 30 knot wind, the aircraft turning downwind requires more than three times the ground distance to execute a 90° turn.

The aircraft turning upwind, due to the 19° drift angle, continues to drift downwind after the turn is commenced until it is heading 330°. Five seconds after commencing the turn, with a heading of 330°, the aircraft is only now beginning to move in an upwind direction relative to its initial ground position. When the turn into wind has been completed, the lateral displacement is about 210 metres upwind from the starting point.

However, the aircraft turning downwind, after only five seconds and reaching a heading of 030°, has increased groundspeed to 108 knots and moved 140 metres downwind. After another five seconds, heading 060°, the groundspeed is up to 116 knots and the lateral displacement is now 375 metres downwind. By the time the turn is completed onto 090°, aircraft groundspeed is 120 knots and lateral displacement 675 metres downwind.



Conclusion

The pilot must be aware of the effect of wind conditions, particularly in hilly or mountainous terrain. The impact of drift, the illusion of increasing or decreasing airspeed, and the difference in time to complete turns into or out of wind can have a real effect on manoeuvring. Gusty winds are a challenge and must be compensated for by adding an adjustment to the manufacturers' recommended speeds.

In hilly or mountainous terrain, when flying from unfamiliar and/or unprepared airstrips, or when operating at high altitudes and hot temperatures, the light aircraft pilot must know the actual capability of the aircraft, and be familiar with the performance numbers in the flight manual. Sound knowledge of aircraft performance, and the impact of wind, density and runway conditions will contribute to safe flying.