WINDSHEAR
for the Private Pilot

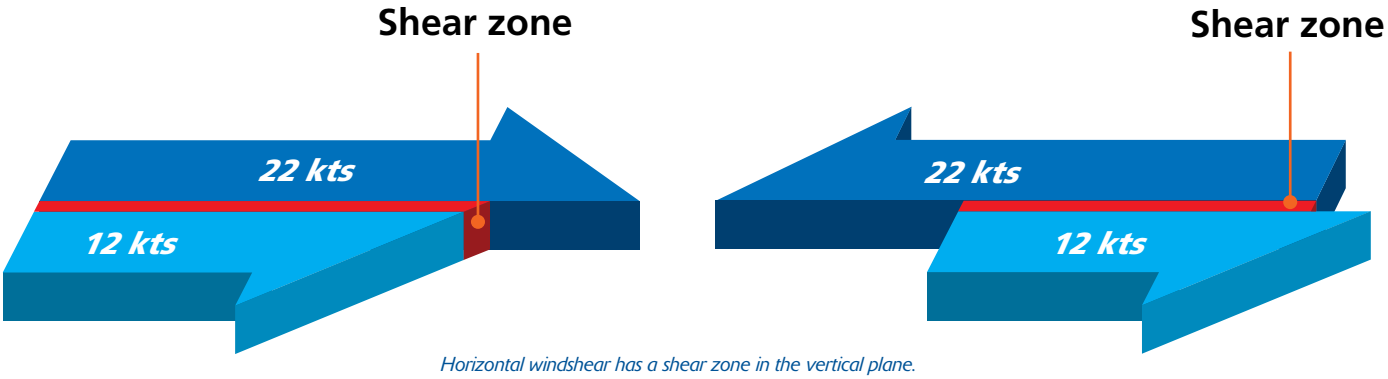
Windshear is a change in wind speed, wind direction, or both. In New Zealand, there are nine reported incidents involving windshear per year on average. Most of these incidents occur in or around the takeoff or landing phases of flight and involve all classes of aircraft from wide-body jets to microlights.

Modern, sophisticated aircraft have technology that can warn pilots of the possibility of windshear, but the recreational pilot must anticipate the likelihood of windshear. For all pilots, the same inherent dangers exist if windshear occurs close to the ground.

There are two types of windshear, horizontal and vertical. Horizontal windshear has a change in direction or speed at the same height, while vertical windshear has a change in direction or speed between two heights.

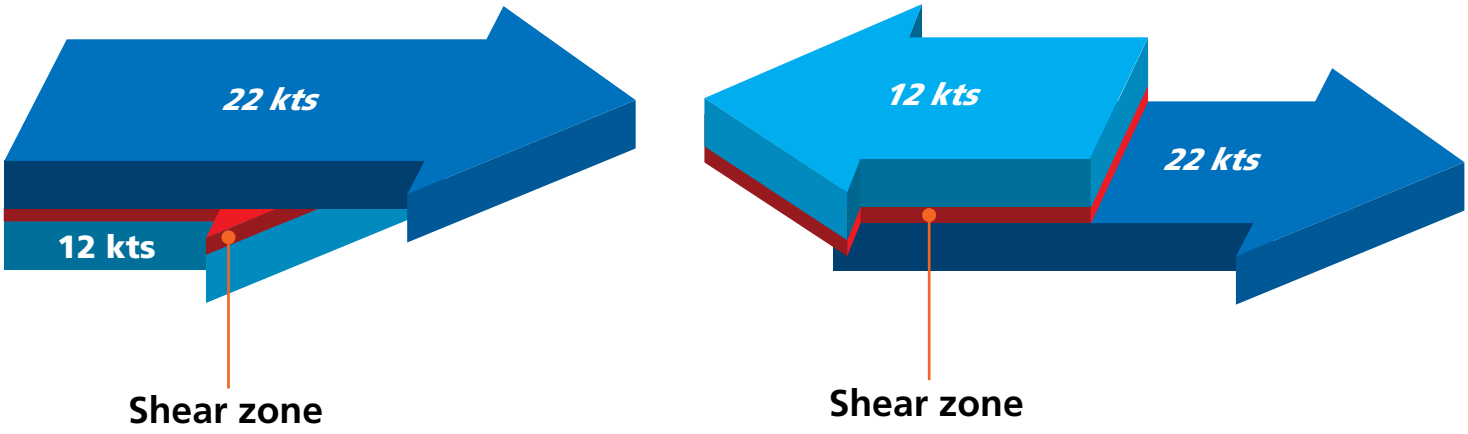
If you encounter a high sink rate near the ground or a significant loss of airspeed, full power is called for without hesitation, whether after takeoff, on approach, or at any other time while flying at low level.

Horizontal Windshear



Horizontal windshear has a shear zone in the vertical plane.

Vertical Windshear



Vertical windshear has a shear zone in the horizontal plane.

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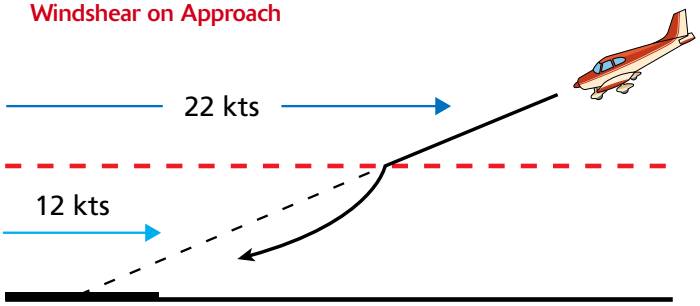
If an aircraft descends into the wind through a vertical windshear zone, with lighter wind below, the aircraft's airspeed will reduce, its angle of descent will steepen, and its rate of descent will increase. This is a dangerous position to be in with limited height to recover, such as during landing.

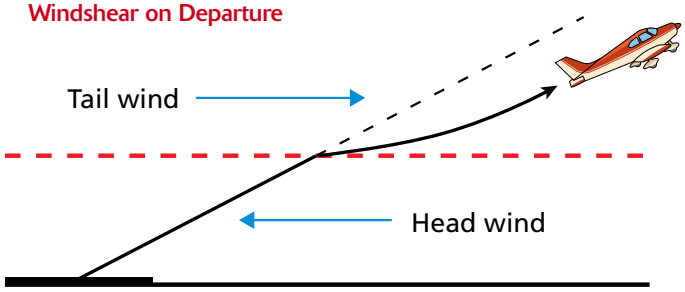
Windshear on Approach



Fly the appropriate approach attitude, and add power to reduce rate of descent.

If an aircraft encounters a reduced headwind or a headwind that turns to a tailwind during takeoff, the aircraft will have an increased takeoff run, reduced rate of climb, and a shallower climb angle. This is also a dangerous position to be in if you need to out-climb terrain.

Windshear on Departure



Maintain the aircraft's best rate of climb attitude (V_Y). Use the aircraft's best angle of climb (V_X) if there are obstructions in your climb-out path.

Causes of Windshear

The common causes of windshear are:

- Thunderstorms
- Downbursts
- Gust fronts
- Surface obstructions
- Frontal activity
- Sea breezes

Thunderstorms

Thunderstorms can produce a range of windshear related hazardous to aircraft, including localised strong and gusty winds, downdraughts, downbursts, gust fronts, and tornadoes.

Downbursts

A *downburst* is defined as a strong *downdraught* which produces an outflow of damaging winds on or near the ground.

A *microburst* is a small *downburst*, having a horizontal range of between 400 m and 4 km. Microbursts normally reach their maximum shear values after 5 to 10 minutes of reaching the ground and usually dissipate within 20 minutes. The danger of microbursts is that the vertical velocity can be as high as 6000 ft/min, and that they are not always obvious or easy to detect.

In general, New Zealand does not have the type of climate that favours microburst activity – but they do happen, as recent tornado activity in Taranaki showed.

Gust Fronts

The *gust front* is the leading edge of the cold dense air from a thunderstorm *downdraught*, which reaches the ground and spreads out in all directions, undercutting the surrounding warmer and less dense air. The gust front is usually located up to 15 NM ahead of the thunderstorm parent cell and travels in the same direction. There is a marked horizontal windshear at ground level following the passage of the leading edge of the gust front. The change in wind surface direction is often as much as 180 degrees, and the wind speed can exceed 50 kt. Such a sudden change in the surface wind, some distance from the storm, can take pilots completely by surprise.

Surface Obstructions

Probably one of the more serious concerns, both in severity and in its likelihood of being encountered, is windshear created by the wind flow around obstacles. By obstacles we mean anything from large hills to isolated buildings, from mountain chains to rows of trees. The effects worsen as windspeed, and the angle at which the wind strikes the obstruction, increase.

Frontal Activity and Sea Breezes

The severity of windshear generated from natural wind patterns such as weather fronts and sea breezes will generally not create unflyable conditions. Special caution is required however, if you are operating the aircraft at low speeds or altitudes, such as for takeoff and landing.

Frontal windshear severity will hinge to some extent on the nature of the front and the associated wind changes. Flying in bad weather configuration (low and slow) at the critical point of the passage of a front should be done with caution.

Coping with Windshear

What windshear does to an aircraft is complex. Obviously, downdraughts and updraughts will have effects, but the loss of airspeed – the loss of lift – can accentuate these effects and, in the worst case scenario, make recovery impossible.

Recognise

The first defence is to develop the ability to recognise the likely presence of windshear before flying into it. Clues which may be available to the pilot include the following:

- Thunderstorms should always be assumed to have the capability of producing hazardous windshear.
- Areas of dust raised by wind, particularly when in the form of a ring below convective clouds, can indicate the presence of a downburst.
- Roll cloud, rolling at the base of a thunderstorm and advancing ahead of the associated rain belt indicates the presence of a gust front.
- Shelf or wedge shaped cloud attached to the base of the storm cloud.

- Look for the effects of wind 'dumping' on trees and crops, or in the ripple and spray patterns on water surfaces.
- When virga (precipitation that evaporates before reaching the ground) is associated with a 20 degree difference between temperature and dewpoint, so called 'dry micro-bursts' may exist.
- Lenticular cloud (smooth lens-shaped altocumulus) indicates the presence of standing waves, usually downwind from a mountain range, and usually with associated rotors (eddies) which produce strong updraughts and downdraughts.
- Strong, gusty surface winds, especially where an aerodrome is located near hills, or where there are comparatively large buildings near the runway, indicate the probability of local windshear and turbulence. Study such obstacles and visualise what effect they may be having on the air (visualise air as a fluid) flowing around them. Be particularly careful using airstrips carved out of a forest; the wind below the tree tops will almost certainly be markedly different to that above them.
- Wind socks indicating different winds are an unmistakeable sign that windshear exists.
- Smoke plumes can indicate windshear by graphically showing the shear effect, possibly with upper and lower sections of the plume moving in different directions.
- TAFs provide the surface and 2000 ft winds. Any variation between the two provides an indication of possible windshear.
- Finally, a most important clue that windshear is present, is a report from another pilot. If you experience significant windshear, pass on details without delay. Give your location, your aircraft type, and the effects of the windshear (eg, the change in airspeed).

Avoid

If any of these occur during the takeoff or landing phase, the likely outcome would have to be assessed on a case-by-case basis, including consideration of how close the windshear is to the takeoff or landing path.

Local knowledge for operating at a particular aerodrome can be useful in making judgement calls. If the winds are strong and the aerodrome is unfamiliar, ask advice from other pilots or air traffic services (but remember, the decisions are still yours).

Some windshear is simply impossible to fly through at low level without serious danger. Microbursts often fit into this category.

Learn to recognise the likelihood of hazardous windshears and avoid them. Make an early decision to avoid an encounter by going around or by delaying the approach or takeoff until conditions improve. If the windshear is strong and is likely to persist – eddies from obstacles for example – do not takeoff or, if you want to land, choose an alternative aerodrome.

Prepare

In New Zealand when there is wind, windshear will be present in one form or another. Pilots should be prepared for windshear and ready to take the appropriate action the instant that it is required.

When taking off, configure the aircraft for maximum performance. Use all of the runway length available. If runway length permits, delay your rotation until you have reached a higher airspeed. When required, do not reduce power too soon after takeoff. Plan the after-takeoff path to avoid having to climb above high obstacles.

On approach, use a higher than normal airspeed. As a general rule, add half the amount that the wind is gusting, to your approach speed. Typically, no more than 20 kt, higher if runway length permits. Maintain the increase until the flare.

If at any stage of flight you recognise the presence of windshear, then by taking preventative or precautionary action, you are far less likely to need to take any recovery action.

Recover

If windshear is encountered unexpectedly, or is more severe than anticipated, the appropriate recovery action should be started without delay. The earlier windshear is recognised, the easier it will be to take adequate recovery action.

How do you know if you've encountered windshear? Sudden uncommanded variations in airspeed of plus or minus 15 kt, and in vertical speed of plus or minus 500 ft/min are some indications of severe windshear. If while on approach you need to significantly increase or decrease your throttle setting, then this can also be an indicator of windshear.

To recognise less severe windshear, pilots should be in the habit of flying a stabilised approach.

The stabilised approach concept has much to offer the general aviation pilot in addition to improving the ability to cope with windshear. The technique involves, as far as practicable, establishing the aircraft on the glide slope in the landing configuration as early as possible and flying the appropriate constant airspeed, pitch attitude, and rate of descent by the smooth application of power and elevator control down to the flare.

If a stabilised approach is your normal routine, then you will find it much easier to recognise any abnormal deviations in airspeed, glide slope, descent rate, or power requirements caused by windshear.

If strong windshear conditions are evident, and you experience deviation above the normal glide slope, be cautious about reducing power. If the deviation is caused by an updraught, chances are you may soon encounter an equally strong downdraught, which should position you back on the glide slope.

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Local Knowledge

At many aerodromes around New Zealand, in strong wind conditions, low-level windshear exists. These are caused from either local topography (sand dunes, buildings, trees), or sea breezes.

It is very important to anticipate local windshear and have an exit plan.

Here are some examples of conditions at aerodromes where windshear is more common.

Dunedin

Mechanical turbulence resulting from airflow over the nearby hills and ranges (Maungatua Ranges) occurs in conditions of very strong winds from between 320 and 010 degrees. In situations with an increasing northwesterly airstream aloft, there can be a short period just prior to the surface wind becoming northwest when strong low level shear can exist.

During periods of strong northwesterlies at 1000 ft with surface winds variable or northeast less than 10 kt, strong windshear has been reported.

Some low-level windshear can also occur in westerly conditions at about 1000 to 2000 ft with gusty northwest winds at the aerodrome surface.

Pilots have also reported low-level windshear at 1000 to 3000 ft during periods of unstable southwest airstreams, and in the presence of cumulonimbus clouds.

Wellington

Extremely strong and gusty wind conditions aside, there are two types of windshear that affect Wellington: mechanical and sea breeze.

On occasions when the pressure gradient is very weak over central areas of New Zealand and there is sufficient surface heating, a sea breeze can be expected at Wellington aerodrome. As the sea breeze develops, more often than not, there will be a southerly at the southern end at the same time that there is a 5 to10 kt northerly at the northern end. The sea breeze is a shallow phenomenon and there can be a marked difference between the upper air mass and the sea breeze.

In Wellington there is a close relationship between wind direction and turbulence. If a westerly is being broadcast on the ATIS, moderate windshear can be expected.

Moderate to severe windshear is common when the surface wind across Cook Strait is between 250 to 290 degrees and greater than 30 kt. A strong shear zone between 500 and 1000 ft occurs, and is often accompanied by severe turbulence.

Nelson

Significant low-level windshear and turbulence occurs at Nelson when a fresh southwesterly surface wind is replaced by the northeasterly sea breeze. The southwesterly wind continues aloft and there will be a strong windshear, typically between 1500 and 2000 ft. ■

Aerodrome meteorological information supplied courtesy of the New Zealand Meteorological Service.

More About Piston Engine Maintenance

All operators need to be aware of how recent rule changes regarding engine escalations apply to them.

The Rule Changes

On 1 March 2007, Part 91 *General Operating and Flight Rules*, changed to require operators to comply with the applicable engine manufacturer's recommended overhaul periods. The following paragraphs from rule 91.603 *General maintenance requirements* are relevant:

(c) Except as provided in paragraphs (d) to (f), the operator of an aircraft must ensure compliance with the manufacturer's recommended overhaul intervals.

(d) Products and components may be operated beyond the manufacturers recommended TBO if the operator complies with TBO escalation procedures that are detailed in a maintenance programme that is accepted under Part 119 or approved under rule 91.607.

(e) In spite of paragraph (d), a piston engine fitted to an aircraft that is not used for hire or reward operations may be operated beyond the manufacturers recommended TBO if the piston engine is maintained in accordance with an engine TBO escalation programme that is acceptable to the Director.

Manufacturer's Recommended TBO

So where do you find the "manufacturer's recommended TBO"?

Let's consider the Textron Lycoming piston engine, since it is by far the most common piston engine chosen by helicopter manufacturers.

See the Textron Lycoming web site, www.lycoming.com, and follow this path: "Support – Publications – Service Instructions". This list includes Service Instruction 1009AS, which is the document containing all the TBO period information for the various Lycoming piston engine models.

The Service Instruction has a number of important conditions that must be considered when determining the TBO period for any particular engine. One of these conditions is especially relevant to operations involving any, "crop dusting or other chemical application flying".

Lycoming Service Instruction 1009AS limits the TBO of such engines to 1500 hours. This is considerably less than the published engine TBO that applies to engines not involved in, "crop dusting or chemical application flying".