Wind Shear
for the Light Aircraft Pilot

Horizontal wind shear

Horizontal wind shear has a shear zone in the vertical plane.

Wind shear is a sudden change in wind speed, wind direction, or both, encountered in flight. In New Zealand, there are nine reported incidents involving wind shear 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.

Although modern airline aircraft have technology that can alert pilots to the possibility of wind shear, the recreational pilot must rely on observation and reports. For all pilots, the same inherent dangers exist if wind shear is encountered close to the ground.

There are two types of wind shear - horizontal and vertical. Horizontal wind shear is a change in direction or speed at the same height, while vertical wind shear is a change in direction or speed with change of height.

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

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.

Causes of Wind Shear

The common causes of wind shear are:

» Thunderstorms
» Surface obstructions
» Frontal activity
» Sea breezes

Thunderstorms

Thunderstorms can produce a range of wind shear-related hazards to aircraft, including localised strong and gusty winds, downdraughts, downbursts, gust fronts, and tornadoes.

Downburst

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

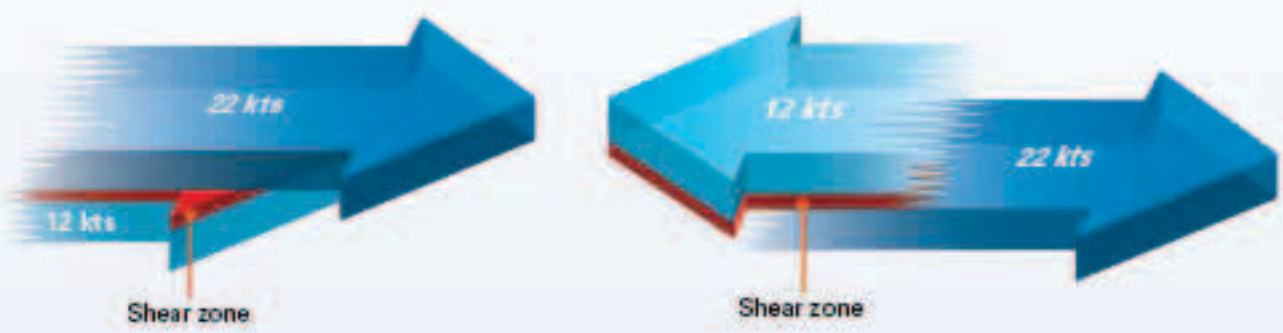
A microburst is a small downburst, having a horizontal range of between 400 m and 4 km. Microbursts normally reach their maximum shear values after 5 to 10 minutes of reaching the ground and usually dissipate within 20 minutes. The danger of microbursts is that the vertical speed can be as high as 6000 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 it can happen.

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

Vertical wind shear

Vertical wind shear has a shear zone in the horizontal plane.



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 wind shear 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 knots. 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 wind shear created by the wind flow around obstacles. These can range in size from isolated buildings to mountains. The effects increase with windspeed and the angle at which the wind strikes the obstruction.

Fronts and Sea Breezes

The severity of wind shear generated from 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 wind shear severity will depend 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 Wind Shear

The effects of wind shear on an aircraft are variable. Obviously, downdraughts and updraughts will have effects, but loss of airspeed – with resulting loss of lift – can accentuate these effects and, in the worst case, make recovery impossible.

Recognise

The first defence is to learn to recognise the likely presence of wind shear before flying into it. Some recognition cues are:

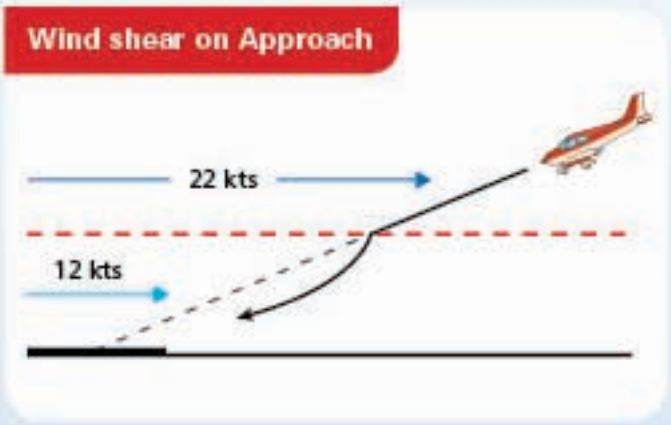
- Thunderstorms should always be assumed to be capable of producing hazardous wind shear.
- Areas of dust in the form of a ring below convective clouds can indicate the presence of a downburst.
- Roll cloud at the base of a thunderstorm and advancing ahead of the associated rain belt indicates the presence 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 microbursts' may exist.
- Lenticular cloud (smooth lens-shaped altocumulus) indicates the presence of standing waves, usually with associated rotors (eddies) beneath, 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, can cause local wind shear and turbulence. Visualise what effect such obstacles may be having on the airflow around them. Be particularly careful using airstrips carved out of a forest, as the wind below the treetops may differ markedly from that above them.
- Windsocks indicating different winds are an unmistakeable

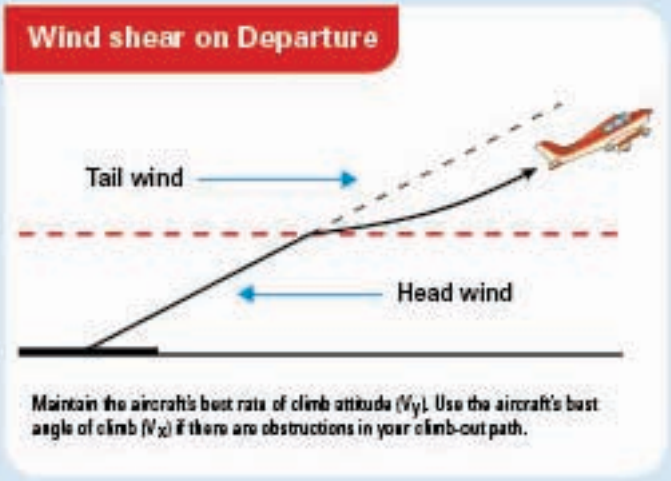
sign that wind shear exists.

» Smoke plumes can show the shear effect, with upper and lower sections of the plume moving in different directions.

» TAFs provide the surface and 2000-foot winds. A large variation between the two can indicate possible wind shear.

» Finally, a most important clue is a report from another pilot. If you experience significant wind shear, pass on details without delay.





Avoid

If any of these are apparent during takeoff or landing, the likely effects would have to be assessed on a case-by-case basis, including consideration of how close the wind shear is to the intended flight path.

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

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

Learn to recognise the signs of hazardous wind shear and avoid them. Decide early to avoid an encounter by delaying the approach or takeoff until conditions improve. If the wind shear is strong and is likely to persist, do not take off or land. Divert if necessary.

Prepare

In New Zealand when there is wind, wind shear can be present in some form. Pilots should anticipate wind shear and be ready to take immediate action if required.

When taking off, configure the aircraft for maximum performance. Use all of the runway length available. If possible, do not reduce power too soon after takeoff. Plan the climb path to avoid high obstacles.

On approach, add half the gust magnitude to your approach speed, up to 20 knots, if runway length permits. Maintain the increased airspeed until the flare.

Recover

If wind shear is encountered unexpectedly, or is more severe than anticipated, the appropriate recovery action should be taken immediately. The earlier the recognition, the more effective the recovery action.

How do you know if you've encountered wind shear? Sudden unexpected variations in airspeed of plus or minus 15 knots, and in vertical speed of plus or minus 500 ft/min are some indications of severe wind shear. On approach, if you need to significantly increase or decrease power, this can also indicate the presence of wind shear.

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 wind shear.

If strong wind shear conditions are evident, and you experience deviation above the normal glide slope, be careful not to reduce power too soon. If the deviation is caused by an updraught, chances are you may soon encounter an equally strong downdraught.

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

If at any stage of flight, recognition of the presence of wind shear and taking preventative or precautionary action is preferable to having to take recovery action.

Local Knowledge

At many aerodromes around New Zealand, low-level wind shear exists in strong wind conditions. This can be due to local topography or adjacent obstructions, and it is very important to anticipate the possibility and to have an exit plan.

Aerodromes where wind shear is more common include Dunedin, Wellington, Queenstown, and Nelson. All of these are subject to the effects of topography on wind flow, and at Nelson, a strong southeasterly may be undercut by a local sea breeze, resulting in a shear zone between the two airflows.

Further Reading

See the GAP booklets *VFR Met* and *Mountain Flying*, both available on the CAA web site, www.caa.govt.nz under "Publications" or by emailing info@caa.govt.nz. ■