SAFETYSENSE LEAFLET 15c
WAKE VORTEX

photos: Bob Stoyles, Cathay Pacific via 'Crewsnews'

1 INTRODUCTION

a) There have been serious and fatal accidents in the UK to light aircraft because pilots were unable to maintain control after being caught in the wake vortex or helicopter downwash generated by heavier aircraft. The hazard to light aircraft is most likely at airports where general aviation mixes with airline traffic.

b) All aircraft generate vortices at the wing tips as a consequence of producing lift. **The heavier the aircraft and the slower it is flying, the stronger the vortex**. Among other factors, the size of the vortex is proportional to the span of the aircraft which generates it, for instance a Boeing 747, with a span of 65 metres, trails a vortex from both wingtips each with a diameter of around 65 metres.

c) At low altitudes, vortices generally persist for as long as 80 seconds, but **in very light or calm wind conditions they can last for up to two and a half minutes**. Once formed, vortices continue to descend until they decay (or reach the ground). Decay is usually sudden and occurs more quickly in windy conditions. Cross-winds can carry a vortex away from the flight path of the aircraft. For each nautical mile behind an aircraft, the vortex the aircraft generates will typically have descended between 100 and 200 ft.

d) Generally, the lighter the aircraft you are flying, the greater the degree of upset if you encounter a wake vortex. Thus, a light aircraft will be vulnerable to the vortices of a similar sized aircraft ahead of it, and microlight aircraft will be even more vulnerable.

e) Aeronautical Information Circular (AIC) P 072/2010 'Wake Turbulence' provides detailed information including aircraft weight categories and the separation which controllers are required to provide between aircraft of different categories.

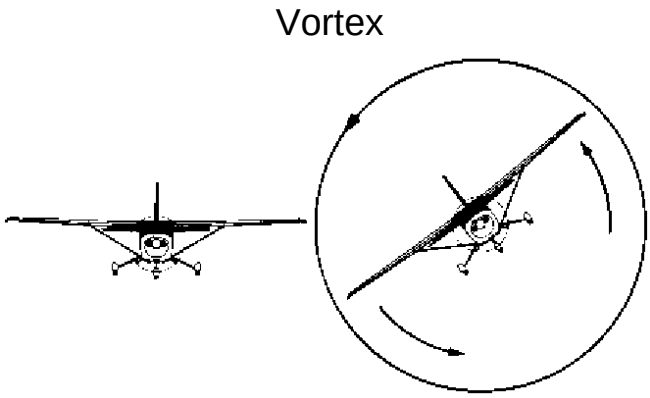
f) The AIC provides advice for avoiding vortices in all phases of flight. The simple advice for light aircraft pilots is 'Avoid crossing below or close behind the flight path of a heavier aircraft'.

g) Jet blast and prop wash may also cause considerable turbulence, but are not covered in this leaflet.

2 VORTEX ENCOUNTERS

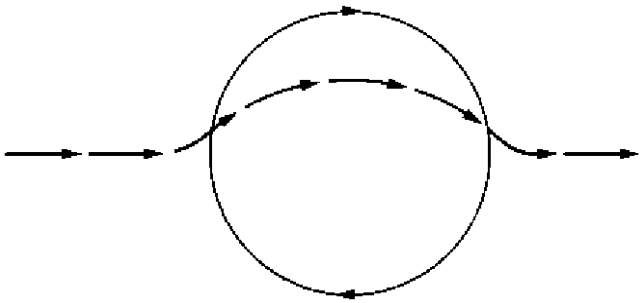
a) A light aircraft penetrating a vortex from a larger aircraft on a similar trajectory and axis can experience a severe roll. In the worst cases it may be beyond the power of the ailerons to counteract the roll. Even executive jets have been rolled upside down.

Same Trajectory Encounter



b) If the vortex is entered at right angles to its axis, rapid vertical and pitch displacements with airspeed changes are likely. An oblique entry, the most likely event, will have symptoms of both.

Right Angle Encounter

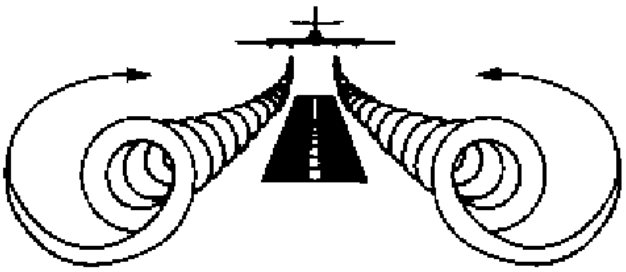


Vertical and Pitch Changes *Airspeed Change* *Vertical and Pitch Changes*

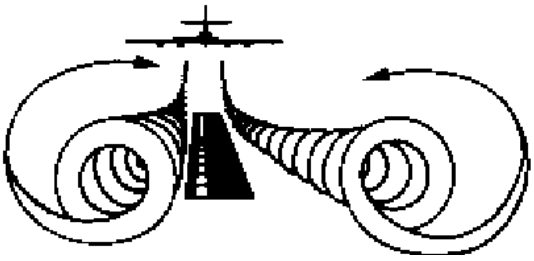
c) Although a vortex encounter at altitude is uncomfortable and alarming, it should be recoverable. However, any loose objects in the cockpit may be scattered about. A Piper PA23 Aztec was flying north–south at 1000 ft, 7½ NM west of Heathrow, underneath the approach path. The Aztec was almost turned on its back by the vortex from a Boeing 757 on the approach which had crossed its track at 2500 ft. The wind at Heathrow was calm.

d) A significant proportion of the wake vortex incidents reported in the UK occur below 200 feet, i.e. just before landing where there may not be room to recover. An accident in the UK badly damaged a Robin aircraft, which it appears got too close behind a landing Short SD360. At 100–150 ft the right wing and nose dropped and the aircraft did not respond to control inputs, descended rapidly and hit a hedge. Estimated separation was about 3 NM. **The wind speed was reported as 2 kt**. Incidents including fatal accidents have also occurred shortly after take-off, which is when the affected aircraft is most likely to be directly behind a larger aircraft.

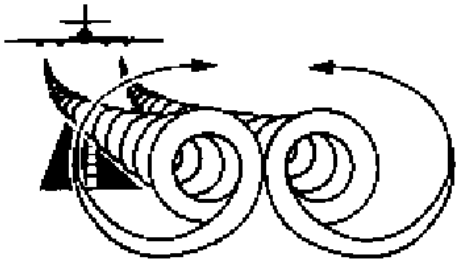
e) Close to the ground, vortices generally persist for about 80 seconds where their effect is most hazardous. They tend to move apart at about 5 kt in still air, so a crosswind component of 5 kt can keep the upwind vortex stationary on or near the runway while the downwind vortex moves away at about 10 kt. In crosswinds of more than 5 kt, the area of hazard is not necessarily aligned with the flight path of the aircraft ahead. Take particular care at airfields where intersecting runways are both in use.



HEADWIND LESS THAN 10 KNOTS



CROSSWIND LESS THAN 5 KNOTS



CROSSWIND OVER 5 KNOTS

At very low altitude the area of hazard is not necessarily aligned with the flight path of the aircraft ahead.

3 AIR TRAFFIC CONTROL

a) At UK airports where there are commercial movements, an ATC service will be provided with the possible exception of some Highlands and Islands aerodromes. The controllers will advise pilots of the recommended interval; e.g. "*Golf November Tango, you are number two to a Boeing 737, caution wake turbulence, the recommended distance is five miles, report final".*

b) **For VFR arrivals vortex spacing is the responsibility of the pilot**; however, the recommended distance will be given by ATC **but not by AFISO/Air Ground Service**. If in doubt, use greater spacing.

c) Read the AIC so that you will be familiar with the weight categories, e.g. 'heavy' includes all wide-bodied airliners. Also become familiar with the spacing minima which ATC will apply.

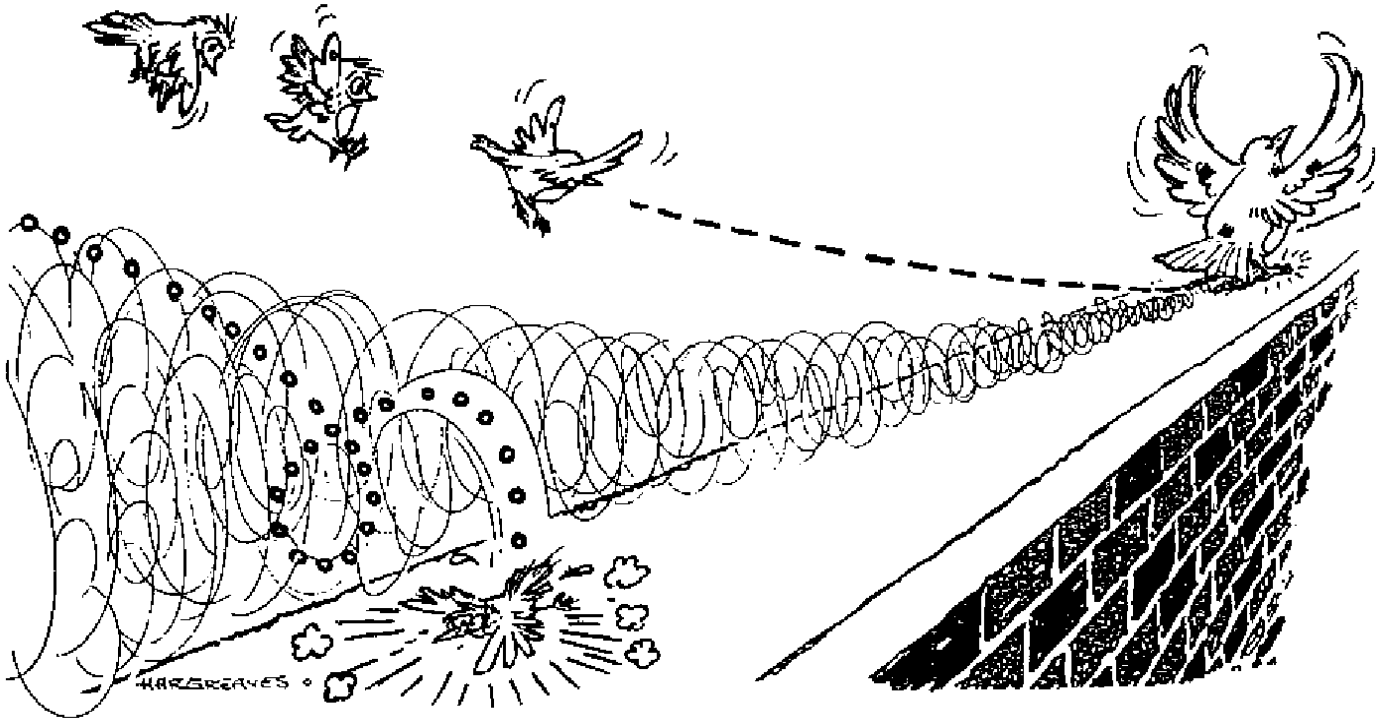
d) Some large narrow-bodied aircraft present a particular hazard to lighter aircraft. Experience has shown that the Boeing 757 creates particularly strong vortices. Caution is recommended for all pilots following such aircraft, particularly on approach. Additional spacing (with the agreement of ATC) is recommended.

4 AVOIDANCE - APPROACH

a) Since the vortices are invisible, although occasionally the cores can be seen in very humid conditions, they are difficult to avoid unless you have a good 'mental' picture of where they occur.

b) There are two techniques which can be employed:

- Distance can be judged visually by runway length – most major airports have runways between one and two nautical miles long (1,850 and 3,700 metres). Thus, if the recommended spacing is six miles, then you need three to six runway lengths between yourself and the aircraft ahead.
- If the aircraft on the approach ahead of you is much heavier than your own type, try to keep it in sight. In general, vortices drift downwards, **so fly above** and to the upwind side of the lead aircraft's flight path. Obviously as you get closer to the runway lateral displacement has to be reduced, so land beyond the point where the heavier aircraft touched down as generation of vortices ceases when the nosewheel contacts the runway. The heavier the type ahead, the longer the runway is likely to be, so stopping a light aircraft should not be a problem – it may even save you some taxi time! Airliners almost always approach on a 3° glide slope, light aircraft can readily accept steeper angles.



Courtesy- Hargreaves

5 AVOIDANCE – DEPARTURE

a) **Vortices are generated as the aircraft rotates on take-off**, so the time interval between departures specified in the AIC starts from rotation. For example, a light aircraft taking off behind a Boeing 737 should allow an interval of at least two minutes if commencing take-off from the same point, and at least three minutes if taking off from a point part-way up the same runway.

b) Although you may think you can avoid the vortex by lifting off early and climbing above the vortex, most commercial aircraft will climb much more steeply than a light aircraft once they have accelerated. In order to avoid entering the vortex you would need to turn early and fly well clear of the preceding aircraft's flight path.

6 HELICOPTERS

a) The AIC specifies minimum spacing between light aircraft and large helicopters. **However, it is considered that any helicopter in forward flight generates more intense vortices than a fixed-wing aircraft of a similar weight**. For example, the S76 is characterised as 'light', so no minimum spacing is recommended for another 'light' aircraft, but such a light aircraft has been turned over by an S76 vortex. When following a helicopter, pilots of light aircraft should consider allowing a greater spacing than they would behind a fixed-wing aircraft of similar size, especially if the helicopter has been hovering.

SikorskyS76 – Photo FAA Technical Center, Mr J Sackett

b) Helicopters with rotors turning create a blast of air outwards in all directions, the strongest effect being downwind. This effect is not so significant when the helicopter with rotors turning is on the ground. It is most severe during hovering and hover taxiing, when the rotors are generating enough lift to support the full weight of the helicopter, and this creates the greatest downwash, out to a distance of approximately three times the rotor diameter.

c) During an approach it may not be possible to determine which of the stages of flight the helicopter is at, nor the helicopter pilot's immediate intentions. In these circumstances, pilots of light aircraft should aim to keep as far away as possible. In particular, if there is a helicopter on or near the runway, and if runway length permits, consider landing further down the runway to avoid being caught by rotorwash. **If in doubt, make an early decision to go-around**.

d) Helicopter pilots should consider the effect on others of their wake and minimise time spent in the hover close to the paths of other aircraft. For example, they should quickly move well clear of the runway to which they have approached, especially when on the upwind side of it. Where that is not possible, they should place their helicopter on the ground as soon as possible, ground taxiing rather than hover taxiing.

7 MICROLIGHTS

a) Microlights and very light aircraft are more susceptible than other GA aircraft to the effects from wake vortex. Control problems have been experienced when one has encountered the vortex of a single-engined piston training aeroplane.

b) Pilots of microlights should consider treating every aircraft in front of them as being one category higher than listed in the AIC.

c) Hang gliders and paragliders (including powered parachutes) can expect to be affected even more than microlights. Parachute canopies may collapse, as shown below.

photo courtesy 'Skywings'

8 REPORTING

a) As detailed in AIC P 089/2010, 'The National Wake Turbulence Encounter Reporting Scheme', NATS maintains a wake vortex database to monitor incident rates. All suspected wake vortex incidents should be **reported immediately to ATC by radio** and followed up after landing using form SRG 1423 'Wake Turbulence Report Form' (Pilots/ATCOs). The form can be submitted to the CAA as an Occurrence Report if that would normally be required by CAP 382, for example if significant handling difficulties are experienced.

b) Reports (except those doubling as occurrence reports) should be sent to:

Wake Vortex Analysis Team
NATS
Corporate Technical Centre
4000 Parkway
Whiteley
Fareham
Hampshire PO15 7FL,

Tel: 01489 6152153
Fax: 01489 615215
E-mail: waketurbulence@nats.co.uk

9 FURTHER INFORMATION

A graphic 17-minute video, AF 9468 'Wake Turbulence – The Unseen Menace', is available from:

The British Defence Film Library,
Chalfont Grove,
Chalfont St Peter,
Gerrards Cross,
Bucks SL9 8TN.

Tel: 01494 878237
Fax: 01494 878007.

It provides a useful illustration of the problem to those who fly both small and large aircraft, and also for Air Traffic Services personnel.

10 SUMMARY

- Wake vortices are generally invisible.
- Vortices last longer in calm or light wind conditions and are therefore at their most hazardous then.
- They are most dangerous close to the ground.
- The heavier an aircraft, and the slower it is flying, the stronger its vortex and the greater the risk to following aircraft.
- The lighter the aircraft you are flying, the more vulnerable it is.
- When an aeroplane's nosewheel is on the ground, there are no vortices.
- On departure, use the appropriate time interval when following a heavier aircraft:

  two minutes if starting the take-off at the same point; and

  three minutes if taking off part-way along the same runway.
- When taking off behind a departing heavier aircraft, note its rotation point so that you can lift off before that point and climb above the vortex. If you cannot – WAIT.
- On the approach, avoid vortices by flying above and upwind of the lead aircraft's flight path.
- When following a heavier aircraft which has already landed, note its touchdown point and land beyond it. If there isn't room – GO AROUND.
- Apply the spacing advised by ATC, using runway length as a guide to judging distance.
- When following a large helicopter consider allowing a bigger gap than for the equivalent sized aeroplane.
- Keep well away from helicopters with rotors turning, they may be hovering or hover taxiing – it can be difficult to judge.
- If in doubt – WAIT.
- All encounters should be reported.

Full details are published in AIC P 072/2010, 'Wake Turbulence' and the reporting details in AIC P 089/2010, 'The National Wake Turbulence Encounter Reporting Scheme'.