GENERAL AVIATION SAFETY SENSE

CIVIL AVIATION AUTHORITY

15B

WAKE VORTEX

GENERAL AVIATION SAFETY SENSE LEAFLET 15B

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 The most recent Aeronautical Information Circular (AIC) 17/1999 (Pink 188) 'Wake Turbulence' provides detailed information including aircraft weight categories and recommended spacings.

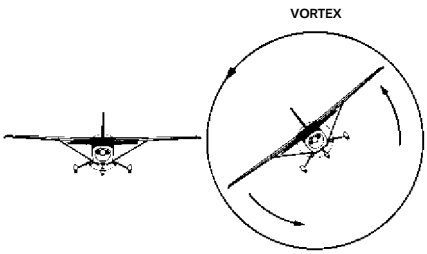
f The AIC provides advice for avoiding vortices in all phases of flight. The simple advice for light aircraft pilots is, 'Avoid crossing below or close behind the flight path of a heavier aircraft'.

g Jet blast and prop wash are not covered in this leaflet.

2 VORTEX ENCOUNTERS

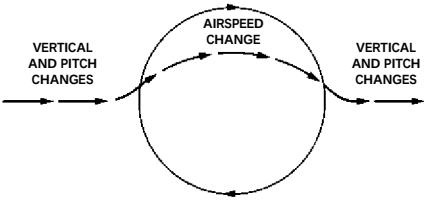
a A light aircraft penetrating a vortex from a larger aircraft on a similar trajectory and axis can experience a severe roll. In the worst cases it may be beyond the power of the ailerons to counteract the roll. Even executive jets have been rolled upside down.

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



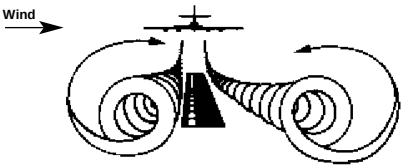
c Although a vortex encounter at altitude is uncomfortable and alarming, it should be recoverable. However, any loose objects in the cockpit may be scattered about. A Piper PA23 Aztec was flying north–south at 1000 ft 7½ nm west of Heathrow, underneath the approach path. The Aztec was almost turned on 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 ie 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 kts**. 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.

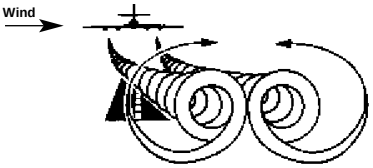
e Close to the ground vortices generally persist for about 80 seconds where their effect is most hazardous. They tend to move apart at about 5 knots in still air, so a crosswind component of 5 knots can keep the upwind vortex stationary on or near the runway while the downwind vortex moves away at about 10 knots. In crosswinds of more than 5 knots, 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.

HEADWINDS LESS THAN 10 KNOTS

LIGHT CROSSWIND – LESS THAN 5 KNOTS



CROSSWIND – OVER 5 KNOTS



At very low altitude the area of hazard is not necessarily aligned with the flightpath 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 ; i.e. *'Golf November Tango, you are number two to a Boeing 737, the recommended wake vortex spacing is 6 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.

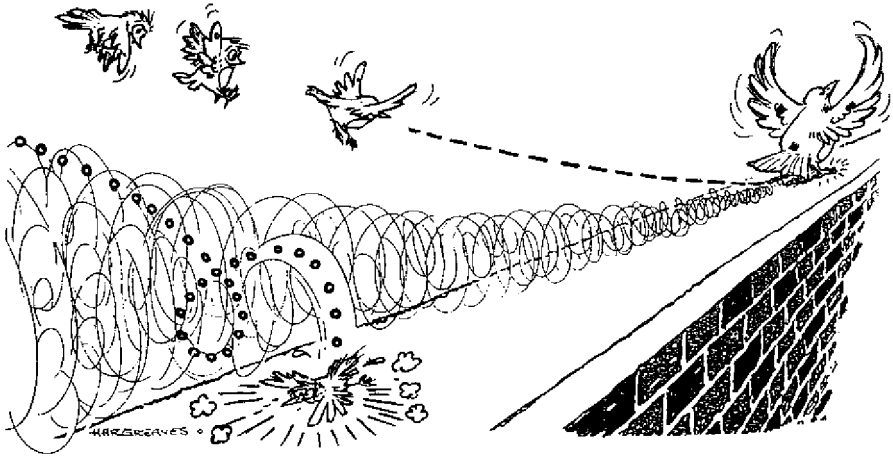
c Read the AIC so that you will be familiar with the weight categories, eg 'heavy' includes all wide-bodied airliners together with Concorde, as well as the spacing minima which ATC will apply.

d Furthermore, some large narrow bodied aircraft, such as the Boeing 757 and VC10, present a particular hazard to lighter aircraft. Experience has shown that the B757 creates particularly strong vortices. Caution is recommended for all pilots following such aircraft, particular on approach, and additional spacing is recommended with the agreement of ATC.

4 VORTEX 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:–



Courtesy – Hargreaves

- Distance can be judged visually by runway length – most major airports have runways between one and 2 nautical miles long (1850 and 3700 metres). Thus, if the recommended spacing is 6 miles, then you need 3 to 6 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 taxy time! Airliners almost always approach on a 3° glide slope, light aircraft can readily accept steeper angles.

5 VORTEX AVOIDANCE – DEPARTURE

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 2 minutes if commencing take-off from the same point, and 3 minutes if taking off from a point part-way up the same runway.

6 HELICOPTERS

a The AIC specifies minimum spacing between light aircraft and the Sikorsky S61N or similar large helicopters (note that there was a fatal accident to a Piper Warrior in 1992 at Oxford). **It is thought that helicopters in forward flight can generate more intense vortices than fixed-wing aircraft of a similar weight.** When following a helicopter, pilots of light aircraft should consider allowing a larger spacing than would normally be used behind a fixed-wing aircraft of similar size.

Sikorsky S76 – 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 taxying when the rotors are generating enough lift to support the full weight of the helicopter, and this creates the greatest downwash. **During an approach it may not be possible to determine which of the stages of flight the helicopter is at.** 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.**

7 REPORTING

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 CA 1695 'Wake Vortex Report Form' (Forms are available from Westward Digital Limited – address at end of leaflet.) If an Occurrence Report (Form CA 1673) is used to report wake turbulence, this will automatically be copied to the database office, a separate Wake Vortex Report need not be sent but detailed information is most useful. Reports should be sent to:

Wake Vortex and Radar Analysis Incidents,
Room HG05,
Air Traffic Management Development Centre,
National Air Traffic Services Ltd,
Bournemouth Airport,
Christchurch,
Dorset, BH23 6DF.
Tel: 01202 472398
Fax: 01202 472236

8 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 costs £60 including Postage and Packing on the UK mainland, VAT extra. It is useful to those who fly both small and large aircraft, as well as for ATC staff.

9 SUMMARY

- **Wake vortices are generally invisible.**
- **Vortices last longer in calm or light wind conditions and are therefore at their most hazardous.**
- **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 – 2 minutes if starting the take-off at the same point, 3 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 flightpath.**
- **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 taxying – it can be difficult to judge.**
- **If in doubt – WAIT.**
- **Full details are published in AIC 19/1999 (Pink 188), 'Wake Turbulence'.**
- **ALL encounters should be reported.**

KNOWLEDGE, PREPARATION, PRACTICE

Other leaflets in this series:

1C	*Good Airmanship Guide*
2B	*Care of Passengers*
3C	*Winter Flying*
5D	*VFR Navigation*
6C	*Aerodrome Sense*
7B	*Aeroplane Performance*
8D	*Air Traffic Services Outside Controlled Airspace*
9A	*Weight and Balance*
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11	*Interception Procedures*
12C	*Strip Sense*
13A	*Collision Avoidance*
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20A	*VFR Flight Plans*
21A	*Ditching*
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23	*Pilots – it's your Decision*
24	*Pilot Health*

New leaflets will appear from time to time on a non-regular basis.

This leaflet does not supersede or replace any formal documents.

If clubs, organisations or individuals wish to receive further copies, please write to Westward documedia Limited, 37 Windsor Street, Cheltenham, Glos GL52 2DG. Fax. No. 01242 584139. Telephone 01242 235151.

Suggestions and technical queries to SRG Safety Promotion Section, Aviation House, Gatwick Airport, West Sussex RH6 0YR. Telephone 01293 573225/7.

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NATIONAL AIR TRAFFIC SERVICES LTD

WAKE VORTEX REPORT (AND OCCURRENCE REPORT IF APPLICABLE)

IMPORTANT:
IS THIS INCIDENT REPORTABLE UNDER THE MOR SYSTEM? *YES/NO

This form is acceptable for occurrence reporting and will be forwarded to Safety Data Department if required.

For use by pilots involved in Wake Vortex incidents, including any which qualify as Reportable Occurrence under Article 106 of the ANO (as amended).

This information is requested by the Civil Aviation Authority in support of investigations into the phenomenon of Wake Vortex.

We ask for your co-operation in completing all sections.

*(*Circle the appropriate reply only)*

SECTION A – GENERAL

1 Date of Incident _____ 2 Time (UTC) _____

3 A/C Type and Series _____ 4 Registration _____

5 Operator _____ SQUAWK _____

6 Flight No. _____ from _____ to _____

7 Weight/kg _____ (*at Incident/Take-off weight) _____

8 IAS/kts _____ Heading/degrees _____

9 Height/Altitude/FL _____

10 Altimeter Setting _____ (*QFE/QNH/Standard)

11 Configuration (Flaps/Undercarriage etc.) _____

12 Degree of NATURAL turbulence *NONE/LIGHT/MODERATE/SEVERE

SECTION B – PHASE OF FLIGHT

13 *TAKE OFF/INIT CLIMB/CLIMB/CRUISE/DESCENT/HOLDING/APPROACH/FINALS/TOUCH-DOWN/TAXIING

at *EGLL/EGCC/EGKK/OTHER (Please Specify) _____

Runway _____

14 Were you turning? *NO/LEFT/RIGHT

15 Which Holding Facility were you in if any? _____

16 Were you *HIGH/LOW/ON Glidepath?

17 Were you *LEFT/RIGHT/ON Centre-line?

PILOTS OF LEAD AIRCRAFT WHO DID NOT EXPERIENCE WAKE VORTEX SHOULD OMIT SECTION C AND CONTINUE TO SECTION D AT THE BOTTOM OF THIS PAGE.

SECTION C – DETAILS OF INCIDENT

18 What made you suspect Wake Vortex as the cause of the disturbance? _____

_____

_____

_____

19 Did you experience vertical acceleration? *YES / NO

If YES please describe briefly _____

_____

20 What was the change in attitude? (please estimate angle)

Pitch _____° Roll _____° Yaw _____°

21 What was the change in Altitude if any? _____ *INCREASE/DECREASE

22 Was there buffeting? *YES/NO

23 Was there stick shake? *YES/NO

24 Was the Autopilot engaged? *YES/NO

25 Was the Autothrottle engaged? *YES/NO

26 What control action was taken? *NONE/GO-AROUND/RUNWAY CHANGE/OTHER

Please describe briefly _____

_____

_____

27 Could you see the aircraft suspected of causing the wake vortex? *YES/NO

If YES, what was it? _____ and where was it relative to your position?

(Estimated separation distance) _____

Were you aware of the preceding aircraft type before the incident? *YES/NO

SECTION D – OTHER INFORMATION

28 Have you any other comments which you think may be useful? _____

_____

_____

_____

_____

Signed _____

Name (BLOCK CAPITALS) _____ Date _____

When complete please send this form to:

Wake Vortex Incidents
Room GF6, ASR1
Air Traffic Management Development Centre
National Air Traffic Services Ltd
Bournemouth International Airport
Christchurch, Dorset BH23 6DF
Fax: (01202) 472236

THANK YOU FOR YOUR HELP