# AERONAUTICAL INFORMATION CIRCULAR P 001/2015

## UNITED KINGDOM

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## WAKE TURBULENCE

### 1 Introduction

1.1 Attention is drawn to the dangers associated with turbulence caused by aircraft wake vortices. This Circular is re-issued to introduce the concept of using time based separation minima to provide wake turbulence mitigation in a surveillance environment.

1.2 This Circular is intended for all airspace users and Air Navigation Service Providers (ANSPs) and incorporates the ICAO guidance issued in relation to the Airbus A380-800 and states the aircraft weight categories used by ANSPs when sequencing aircraft in the approach and departure phase. This Circular also re-states the general warning on wake vortex characteristics and illustrates a number of wake turbulence avoidance techniques. It continues to encourage reporting of all wake turbulence encounters as a valuable contribution to the development of understanding and safe practice in relation to this important safety topic.

1.3 ICAO uses the term ‘wake turbulence’ to describe the effect of the rotating air masses generated behind the wing tips of aircraft in preference to the term ‘wake vortex’ which describes the nature of the air masses[1].

***Note:*** *[1] Reference ICAO Doc 4444 PANS-ATM Fifteenth Edition 2007, Chapter 4 para 4.9.*

1.4 ICAO PANS-ATM describes separation distances to be applied as ‘wake turbulence’ separation minima[2] and this AIC is consistent with this terminology.

***Note:*** *[2] Reference ICAO Doc 4444 PANS-ATM Fifteenth Edition 2007, Chapter 4 para 4.9.1.1.*

1.5 The United Kingdom has adopted the terminology as described in paragraphs 1.3 and 1.4. The UK uses the ICAO terminology ‘wake turbulence separation minima’ and this terminology is reflected in RTF phraseology.

### 2 Wake Turbulence Weight and Separation Criteria

2.1 The United Kingdom conform in general to the ICAO standards on wake turbulence but with certain modifications to the weight and separation relationship which experience has shown to be advisable for the safety of operations at UK aerodromes.

2.2 Since 1982 the differences between the UK and ICAO criteria have been as follows:

2.2.1 A modification to the Medium and Light weight thresholds and the introduction of a separate category (Small) for separation purposes (see paragraph 2.4).

2.2.2 Some enhancement of the separation minima between certain categories (see paragraph 2.5).

2.2.3 Re-classification of the B707, DC8, VC10 and IL62 series of aircraft from the Heavy to the Medium category. This is a special case as experience has shown that these types of aircraft conform more to the Medium weight group.

2.2.4 In 1997 a further modification was made for the purpose of separation in the approach phase at London Heathrow, London Gatwick, London Stansted and Manchester and London Luton in 1999, by dividing the Medium category for landing aircraft into Upper and Lower Medium. In light of the safe operational experience over the years since 1997 it was decided in 2010 to extend this categorisation to all UK aerodromes.

2.2.5 The following aircraft types are classified as Upper Medium for wake turbulence purposes: B757, B707, DC8, VC10 and IL62. All other ‘Medium’ aircraft types are classified as Lower Medium. All Boeing 757s are classified as Upper Medium for wake turbulence separation application, irrespective of weight. This is due to an unusually high core vortex speed as generated by the B757 wing.

2.3 **Composition of Flight Plans**

2.3.1 Any differences between ICAO and UK criteria will not affect the composition of flight plans that should be completed in accordance with ICAO Doc 4444[3] (PANS ATM) and ICAO State Letter TEC/OPS/SEP - 08-0294.SLG of 8 July 2008

***Note:*** *[3] Doc 4444 does not contain material related to Airbus A380-800. This guidance was issued through the ICAO State Letter System and will be incorporated into PANS-ATM at a later date.*

2.3.2 For example, aircraft weight should be entered as J, H,M or L according to the ICAO Weight Turbulence Categorisation (see paragraph 2.4). It should be noted that within the UK, aircraft with a maximum take-off mass of 136000 kg or greater are required to be announced as ‘Heavy’ or ‘Super’ in the case of the A380, on initial contact with an ATC unit. In the special cases stated in paragraph 2.2.3, where specific aircraft have been taken out of the Heavy category, this initial contact announcement will not be required in the UK, as these aircraft types will be considered as Medium (Upper Medium on approach).

## 2.4 Weight Parameters (Maximum take-off mass (MTOM) in kg)

| Category | ICAO and Flight Plan (kg) | UK Departures (kg) | UK Arrivals (kg) |
|---|---|---|---|
| Heavy (H) | ≥ 136000 | ≥ 136000 | ≥ 136000 |
| Medium (M) | > 7000 & < 136000 | > 40000 & < 136000 | N/A |
| Upper Medium (UM) | N/A | N/A | > 104000 & < 136000 |
| Lower Medium (LM) | N/A | N/A | > 40000 & ≤ 104000 |
| Small (S) (UK only) | N/A | > 17000 & ≤ 40000 | > 17000 & ≤ 40000 |
| Light (L) | ≤ 7000 | ≤ 17000 | ≤ 17000 |

***Note:*** *The Upper and Lower Medium are considered to form the medium category group and is not split for departure wake turbulence separation.*

2.4.1 The wake turbulence category of an aircraft should be indicated on the flight plan (item 9) as J (A380-800), H, M, or L. For purposes of separation in the approach or departure phases within the UK, and regardless of the weight category as entered on the flight plan, aircraft 40000 kg or less and more than 17000 kg will be treated as Small. Aircraft of 17000 kg or less MTOM will be treated as Light. Helicopters such as the Eurocopter AS-332 Super Puma or larger will be treated as Small.

2.4.2 The Airbus A380-800, whilst falling within the Heavy category, has additional wake turbulence separation criteria applied as identified within this Circular. Apart from the additional criteria identified, the A380-800 shall be treated as a Heavy category aircraft in all other circumstances.

## 2.5 Wake Turbulence Categories - UK Fifth Category - Upper Medium

2.5.1 For the purposes of separation in the approach phase at UK aerodromes the B757, B707, DC8, VC10 and IL62 will be treated as Upper Medium.

2.5.2 Although the UK increased the original ICAO three group scheme to four groups to provide an increased level of protection for certain aircraft types, the data that is available provides no evidence that a fifth group is required for departing aircraft.

## 2.6 Wake Turbulence Separation Minima - Final Approach

| Leading Aircraft | Following Aircraft | Wake Turbulence Separation Minima Distance (NM) | |
|---|---|---|---|
| | | ICAO | UK |
| A380-800 | A380-800 | # | # |
| A380-800 | Heavy | 6 | 6 |
| A380-800 | Upper & Lower Medium | 7 * | 7 * |
| A380-800 | Small | N/A | 7 |
| A380-800 | Light | 8 | 8 |
| Heavy | A380-800 | # | # |
| Heavy | Heavy | 4 | 4 |
| Heavy | Upper & Lower Medium | 5 * | 5 |
| Heavy | Small | N/A | 6 |
| Heavy | Light | 6 | 7 |
| Upper Medium | A380-800 | # | # |
| Upper Medium | Heavy | # | # |
| Upper Medium | Upper Medium | 3 | 3 |
| Upper Medium | Lower Medium | N/A | 4 |
| Upper Medium | Small | N/A | 4 |
| Upper Medium | Light | 5 | 6 |
| Lower Medium | A380-800 | # | # |
| Lower Medium | Heavy | # | # |
| Lower Medium | Upper Medium | N/A | # |
| Lower Medium | Lower Medium | # | # |
| Lower Medium | Small | N/A | 3 |
| Lower Medium | Light | 5 | 5 |
| Small | A380-800 | N/A | # |
| Small | Heavy | N/A | # |
| Small | Upper Medium | N/A | # |
| Small | Lower Medium | N/A | # |
| Small | Small | N/A | 3 |
| Small | Light | N/A | 4 |
| Light | A380-800 | # | # |
| Light | Heavy | # | # |
| Light | Upper Medium | # | # |
| Light | Lower Medium | # | # |
| Light | Small | # | # |
| Light | Light | # | # |

**Notes:**
*ICAO does not split the Medium category.
# Signifies that separation for wake turbulence reasons alone is not necessary.

2.6.1 The UK minima specified in the above table are to be applied when:

(a) an aircraft is operating directly behind another aircraft at the same altitude or less than 1000 ft below; or

(b) an aircraft is crossing behind another aircraft at the same altitude or less than 1000 ft below; or

(c) both aircraft are using the same runway or parallel runways separated by less than 760 m (2500 ft).

2.7 **Wake Turbulence Separation Minima - Departures**

| Leading Aircraft | Following Aircraft | Minimum Wake Turbulence Separation at the Time Aircraft are Airborne | |
|---|---|---|---|
| A380-800 | A380-800 | Departing from the same position or from a parallel runway separated by less than 760 m (2500 ft) | No wake turbulence separation minima required* |
| A380-800 | Heavy | | 2 minutes |
| | Medium (Upper & Lower)<br>Small<br>Light | | 3 minutes |
| Heavy | Heavy | | 4 nm or time equivalent |
| Heavy | Medium (Upper & Lower)<br>Small<br>Light | | 2 minutes |
| Medium (Upper & Lower) or Small | Light | | 2 minutes |
| | | | |
| A380-800 | A380-800 | Departing from an intermediate point on the same runway or from an intermediate part of a parallel runway separated by less than 760 m (2500 ft) | No wake turbulence separation required* |
| A380-800 | Heavy | | 3 minutes |
| | Medium (Upper & Lower)<br>Small<br>Light | | 4 minutes |
| Heavy (Full length take-off) | Medium<br>Small<br>Light | | 3 minutes |
| Medium or Small (Full length take-off) | Light | | 3 minutes |

**Note:** *ICAO State Letter TEC/OPS/SEP - 08-0294.SLG of 8 July 2008.

The minima specified in 2.7 apply when the aircraft are using:

(a) the same runway;

(b) parallel runways separated by less than 760 m (2500 ft);

(c) crossing runways if the projected flight path of the second aircraft will cross the projected flight path of the first aircraft at the same altitude or less than 300 m (1000 ft) below;

(d) parallel runways separated by 760 m (2500 ft) or more, if the projected flight path of the second aircraft will cross the projected flight path of the first aircraft at the same altitude or less than 300 m (1000 ft) below.

2.7.1 Wake turbulence minima on departure are applied by ATC by determining airborne times between successive aircraft. Take-off clearance may be issued with an allowance for the anticipated take-off run on the runway. This may result in a take-off clearance being issued at less than the prescribed time interval. However, the airborne time interval will reflect a difference of at least the required time separation.

2.7.2 Pilots do, on occasion, request departure clearance before the minimum time separation has elapsed. On those occasions ATC should apply the minima as prescribed in this AIC, irrespective of the request for reduced separation. It is important for pilots to note that ATC does not have the discretion to reduce separation minima.

2.8 **Wake Turbulence Separation Minima - Displaced Landing Threshold**

2.8.1 A380. If the projected flight paths are expected to cross, a wake turbulence separation of 3 minutes shall be applied between a Light, Small or Medium (Upper & Lower) aircraft and an A380-800 aircraft when operating on a runway with a displaced landing threshold when:

(a) A departing Light, Small or Medium (Upper & Lower) aircraft follow an A380-800 aircraft arrival; or

(b) an arriving Light, Small or Medium aircraft follow an A380-800 aircraft departure.

2.8.2 A 380. If the projected flight paths are expected to cross, a wake turbulence separation of 2 minutes shall be applied between a Heavy aircraft and an A380-000 aircraft when operating on a runway with a displaced landing threshold when:

(a) A departing Heavy aircraft follows an A380-800 aircraft arrival; or

(b) an arriving Heavy aircraft follows an A380-800 aircraft departure.

**Note:** The wake turbulence separation criteria specified in 2.8.2 are interim UK criteria until ICAO publishes guidance in this area.

2.8.3 Other Aircraft categories. If the projected flight paths are expected to cross, wake turbulence separation of 2 minutes shall be provided between Medium (Upper & Lower), Small or Light Aircraft following a Heavy aircraft and between a Light aircraft following a Medium or Small aircraft when operating on a runway with a displaced threshold when:

(a) A departing Medium (Upper & Lower), Small or Light aircraft follow a Heavy arrival or a departing Light aircraft follows a Medium or Small arrival; or

(b) an arriving Medium (Upper & Lower), Small or Light aircraft follow a Heavy aircraft departure, or an arriving Light aircraft follows a departing Medium or Small aircraft.

2.9 **Wake Turbulence Separation Minima - Opposite Direction**

2.9.1 A separation minimum of 3 minutes should be applied between a Light, Small or Medium (Upper & Lower) aircraft and an A380-800 aircraft when the A380-800 aircraft is making a low or missed approach and the Light, Small or Medium aircraft is:

(a) Utilising an opposite-direction runway for take-off; or

(b) landing on the same runway in the opposite direction, or on a parallel opposite-direction runway separated by less than 760 m (2500 ft).

2.9.2 A separation of 2 minutes should be applied between a Medium (Upper & Lower), Small or Light aircraft and a Heavy aircraft., and between a Medium (Upper & Lower) or Small aircraft and a Light aircraft whenever the heavier aircraft is making a low or missed approach and the lighter aircraft is:

(a) Taking-off on the same runway in the opposite direction;

(b) landing on the same runway in the opposite direction;

(c) landing on a parallel opposite direction runway separated by less than 760 m (2500 ft)†

***Note:*** *† At aerodromes where a grass strip is in use in addition to the runway(s), the strip will be counted as a runway for the application of wake turbulence separation minima.*

2.10 **Wake Turbulence Separation Minima - Crossing and Parallel Runways†**

2.10.1 When parallel runways separated by less than 760 m are in use:

(a) Such runways are considered to be single runway, for wake turbulence reasons, and the wake turbulence minima listed in paragraphs 2.6 and 2.7 apply to landing and departing aircraft respectively.

***Note:*** *† At aerodromes where a grass strip is in use in addition to the runway(s), the strip will be counted as a runway for the application of wake turbulence separation minima.*

2.10.2 The final Approach Minima listed in paragraph 2.6 will apply to:

(a) Departures from crossing and/or diverging runways if the **projected** flight paths will cross;

(b) departures from parallel runways more than 760 m (2500 ft) apart if the **projected** flight paths will cross.

2.11 **Wake Turbulence Separation Minima - Intermediate Approach[4]**

2.11.1 The intermediate phase of an approach is associated with each specific Instrument Approach Procedure and airport. Therefore, each airport or terminal area will need to define the area or portion of a procedure where the intermediate approach wake turbulence separation minima apply. This shall be delineated within the MATS Part 2 where necessary.

2.11.2 The following wake turbulence separation criteria minima will be applied in the intermediate segment of an approach:

(a) A minimum wake turbulence separation of 5 nm shall be applied between a Heavy (excluding A380-800) and a Medium (Upper & Lower) or Small aircraft following or crossing behind at the same level or less than 1000 ft below;

(b) A minimum wake turbulence separation of 6 nm shall be applied between a Heavy (excluding A380-800) and a Light aircraft following or crossing behind at the same level or less than 1000 ft below;

(c) the minimum wake turbulence separation for aircraft following the A380-800 at the same level or less than 1000 ft below shall be as per Final Approach (see paragraph 2.6).

***Note:*** *[4] The intermediate approach segment is defined as commencing at the release from holding stack or crossing the holding fix or an intermediate fix to commence positioning for an approach and ends when the aircraft establishes on the localiser or final approach or crosses the Final Approach Fix.*

2.12 **Wake Turbulence Separation Minima – Time Based Separation (TBS) for Final Approach[i]**

2.12.1 NATS has developed an operational concept to utilise time, as opposed to distance, for wake turbulence and surveillance separation within a surveillance environment for application only during the final approach phase of flight.

2.12.2 Time Based Separation is the application of time based wake turbulence separation minima on final approach.

2.12.3 TBS manages risk of wake turbulence encounter by taking account of turbulent decay of wake vortices at lower altitudes due to medium and strong headwinds. TBS separation criteria aim to increase the consistency of time spacing between arriving aircraft, so that the time between successive arrivals in high wind conditions is similar to the times delivered during light wind conditions.

2.12.4 The TBS separation minima provide consistent time separation which are equivalent to the existing distance based separation minima (see section 2.6) in a light headwind – in distance terms this will mean decreasing the equivalent distance separation where medium and stronger winds exhibit accelerated decay. There will be a slight increase in the equivalent distance separation in light winds (where there is less decay of wake vortices). The TBS separation minima are applied by controllers using the same practices and procedures as distance based wake turbulence separation. Application of TBS separation minima makes use of controller tool support indicators, in order that the controller can visualise time separation on a controller's surveillance system display.

2.12.5 The Time Based Separation minima are shown in the table below and are applied for final approach instead of the distance separation minima described in section 2.6. Irrespective of the headwind conditions, an absolute distance based wake turbulence separation minima of 3 NM remains for all wake turbulence separation requirements.

2.12.6 Transition from distance based separation to time based separation: the controller may start to transition to the TBS separation minima when the aircraft is established on base leg, when the TBS indicator support tool is provided to the controller.

***Note:*** *[i]TBS deployment is included within the SESAR Pilot Common Project Implementing Regulation. [Regulation (EU) No 716/2014)].*

| | | Follower | | | | | |
|---|---|---|---|---|---|---|---|
| | | Super Heavy | Heavy | Upper Medium | Lower Medium | Small | Light |
| Leader | Super Heavy A380 | # | 135s | 158s | 158s | 158s | 158s |
| | Heavy<br>≥ 136000 kg | # | 90s | 113s | 113s | 135s | 158s |
| | Upper Medium<br>> 104000 & < 136000 kg | # | # | 68s | 90s | 90s | 135s |
| | Lower Medium<br>> 40000 & ≤ 104000 kg | # | # | # | # | 68s | 113s |
| | Small<br>> 17000 & ≤ 40000 kg | # | # | # | # | 68s | 90s |
| | Light<br>≤ 17000 kg | # | # | # | # | # | # |

***Note:*** *# Signifies that separation for wake turbulence reasons alone is not necessary.*

2.13 **Application of Wake Turbulence Separation Minima**

2.13.1 Where the separation minima required for IFR purposes is greater than the recommended separation for wake turbulence, the IFR minima will apply.

2.13.2 The separation criteria listed are the minima and when applied by ATC may be increased at the discretion of the controller, or at the request of the pilot. It is important to note that a pilot request for increased separation must be made before entering a runway or commencing final approach. Requests made on the runway or final approach may result in a departure delay and/or an avoidable missed approach. It is stressed that where an aircraft has lined up on a runway and take-off clearance is issued; the aircraft must commence take-off without delay.

2.13.3 Aircraft making a touch-and-go or low approach and go around shall be considered as making a departure from an intermediate point on the runway.

2.14 **Probability of Wake Turbulence Encounter**

2.14.1 It must be emphasised that the separation minima stated in this circular cannot entirely remove the possibility of a wake turbulence encounter (see paragraph 6 on research). The objectives of the minima are to reduce the probability of encountering wake turbulence to an acceptably low level and to minimise the magnitude of the upset when an encounter occurs.

2.14.2 Care should always be taken when following a substantially heavier aircraft, especially in conditions of light winds. The majority of serious incidents, close to the ground, occur when winds are light.

2.14.3 Controllers and pilots should be aware of the area up to 1000 ft below and behind an A380-800 or Heavy aircraft, especially at low altitude, where even a momentary wake turbulence encounter may be hazardous.

2.14.4 Particular care should be exercised where the leading aircraft has followed the glide path on final approach from an extended range eg continuous descent approach. Significant wake turbulence encounters have been reported where the following aircraft is vectored and descended onto final approach behind a significantly larger aircraft. Although the correct separation minima may be applied by ATC, pilots should exercise caution if there is a possibility of a vertical flight profile below that of a larger lead aircraft.

## 3 Aircraft Wake Vortex Characteristics

3.1 Wake vortices are present behind every aircraft, including helicopters when in forward flight, but are particularly severe when generated by heavy aircraft. They are most hazardous to aircraft with a small wingspan during take-off, initial climb, final approach and landing phases of flight.

3.2 The characteristics of the wake vortex system generated by an aircraft in flight are determined initially by the aircraft's gross weight, wingspan, aircraft configuration and attitude. Subsequently these characteristics are altered by interactions between the vortices and the ambient atmosphere. After a time, that varies according to the circumstances, from a few seconds to a few minutes after the passage of the aircraft, the effects of the vortex become undetectable.

3.3 For practical purposes, the vortex system in the wake of an aircraft may be regarded as made up of two counter-rotating cylindrical air masses trailing aft from the aircraft (Figures 1 and 2). Typically the two vortices are separated by about three quarters of the aircraft's wingspan. In still air they tend to drift slowly downwards and either level off, usually not more than 1000 ft below the flight path of the aircraft, or on approaching to the ground, move sideways from the track of the generating aircraft at a height roughly equal to half the aircraft's wingspan (see Figure 3).

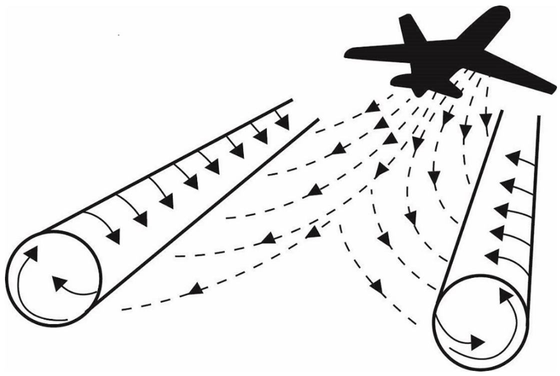

Figure 1: General view of aircraft trailing vortex system.

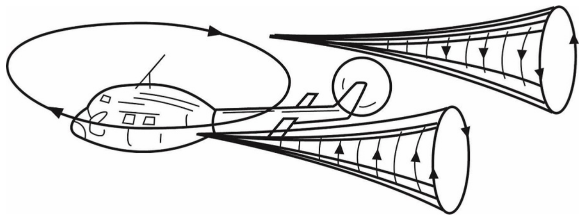

Figure 2: Helicopter Vortices.

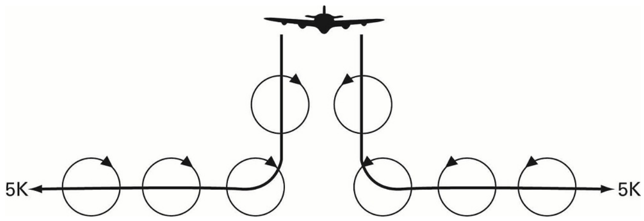


Figure 3: Vortex movement near the ground in still air, viewed from behind the generating aircraft.

3.3.1 The maximum tangential airspeed in the vortex system, which may be as much as 300 ft/sec immediately behind a large aircraft, decays slowly with time. After the passage of the aircraft the tangential airspeed eventually drops sharply as the vortex system disintegrates.

3.4 Wake vortex generation begins when the nose wheel lifts off the runway on take-off and continues until the nose wheel touches down on landing.

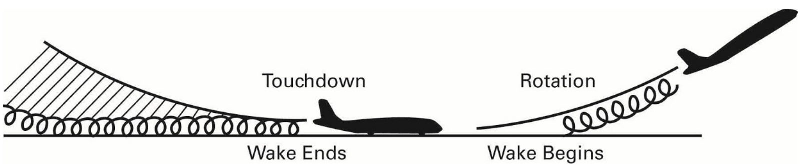


Figure 4: Vortex generation in the landing and take-off phases of flight.

3.4.1 Vortex strength increases with the weight of the generating aircraft. With the aircraft in a given configuration, the vortex strength decreases with the increasing aircraft speed; and for a given weight and speed the vortex strength is greatest when the aircraft is in a clean configuration. There is some evidence that for a given weight and speed a helicopter produces a stronger vortex than a fixed-wing aircraft.

3.5 In a stable airflow, the wake vortex system described in paragraph 3.3 will drift with the wind. Figure 5 shows the possible effect of a crosswind on the motion of a vortex pair close to the ground.

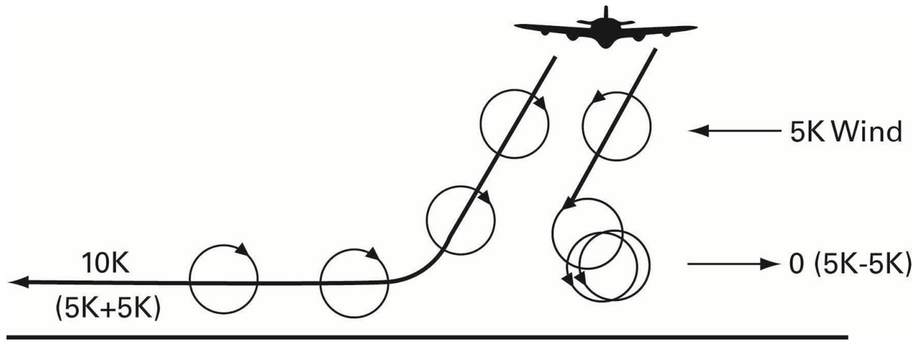


Figure 5: Vortex movement near the ground in a light crosswind, viewed from behind the generating aircraft.

3.5.1 Wind shear causes the two vortices to descend at different rates and, close to the ground, may cause one of the vortices to rise. Atmospheric turbulence and high winds close to the ground hasten the decay and disintegration of vortices. Special attention needs to be given to situations of light wind, when vortices may stay in the approach and touchdown areas of aerodromes or sink into the landing or takeoff paths of succeeding aircraft.

## 4 Wake Turbulence Avoidance - Advice to Pilots

4.1 The wake of a large aircraft deserves the respect of all pilots. The area up to 1000 ft below and behind such aircraft should be avoided, especially at low altitude. When an aircraft is at cruise speed, turbulence may persist at considerable distances behind. By far the greater proportion of reported wake turbulence encounters occur in the approach phase. However, reports of wake turbulence encounters do occur in the departure phase of flight. The separation minima listed in paragraph 2 are designed specifically for use in these areas. Pilots who find themselves in a position of having to provide their own separation from large aircraft in the approach phase are reminded that the wake turbulence separations listed in paragraph 2 are the minima. Where increased separation is considered necessary, the pilot should inform ATC, where practicable before joining final approach.

4.2 When the disposition of traffic is such that there appears to be the possibility of a wake turbulence encounter, then a wake turbulence avoidance manoeuvre of the type listed below may be utilised. Some of the situations represented are more likely to be utilised in a mixed IFR/VFR enviroment.

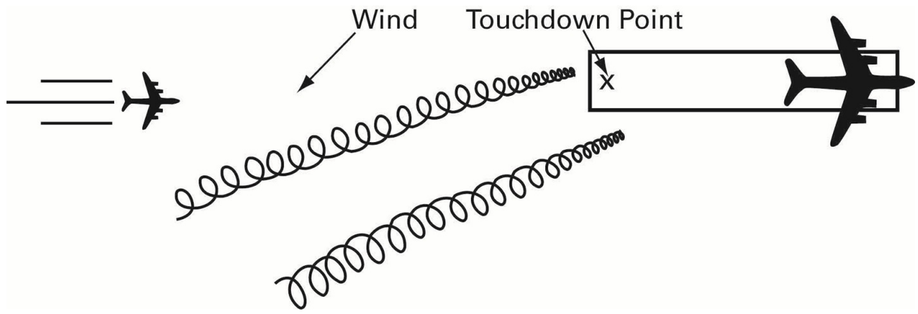


Figure 6: Landing behind a large aircraft on the same runway.

Stay at or above the large aircraft’s final approach path. Note its touchdown point and land beyond it.

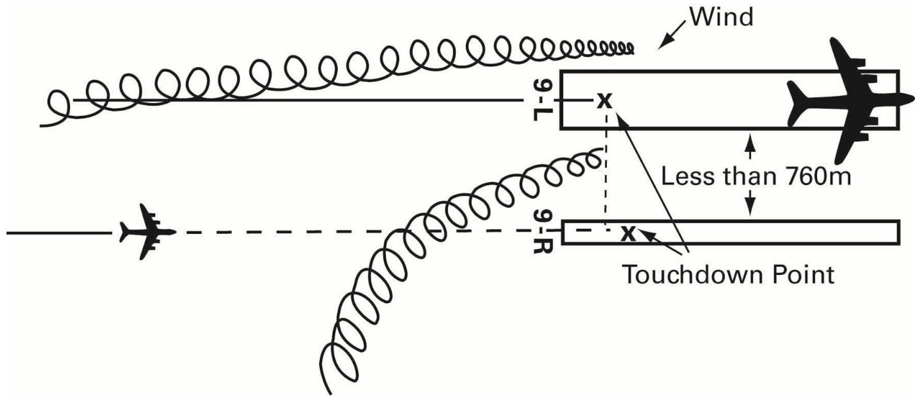


Figure 7: Landing behind a large aircraft on a parallel runway when the parallel runway is closer than 760 m. Consider possible drift to the runway. Stay at or above the large aircraft’s final approach path and observe its touchdown point.

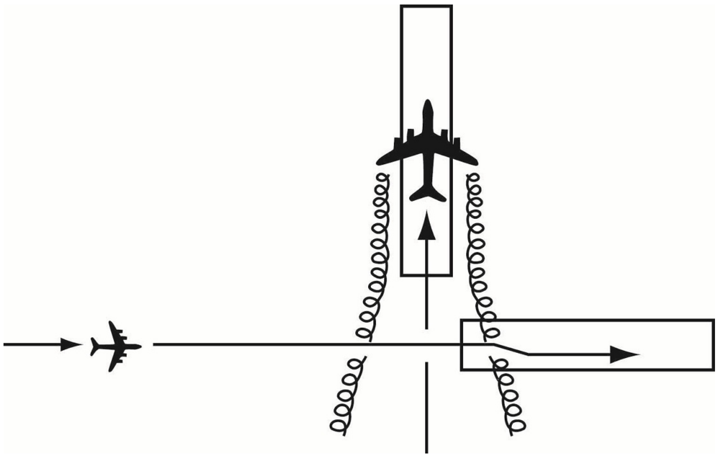

Figure 8: Landing behind a large aircraft - crossing runway. Cross above the large aircraft's flight path.

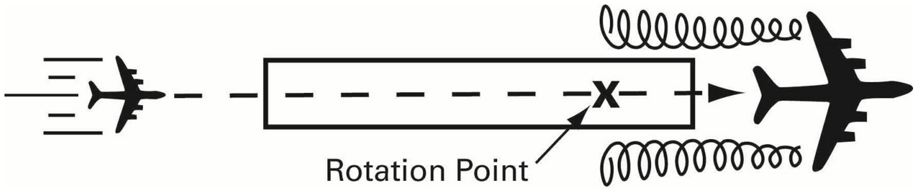


Figure 9: Landing behind a departing large aircraft - same runway.

Note the large aircraft's rotation point and land well before it.

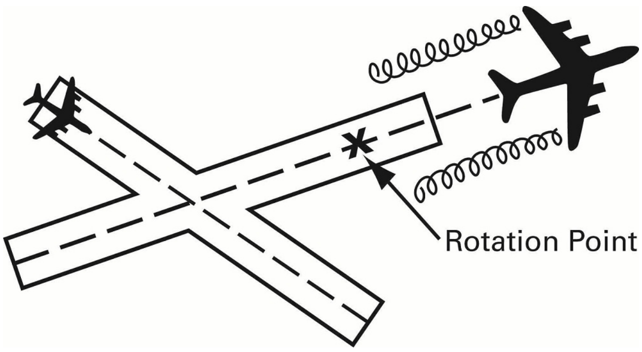


Figure 10: Rotation point beyond the intersection.

Note the large aircraft's rotation point. If it is past the intersection continue the approach and land.

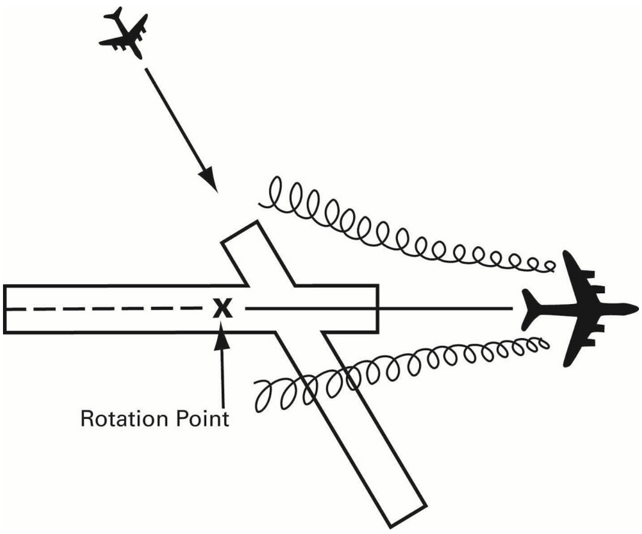


Figure 11: Rotation point prior to intersection.

If the large aircraft rotates prior to the intersection, avoid flight below its flight path. Abandon the approach unless a landing is assured well before reaching the intersection.

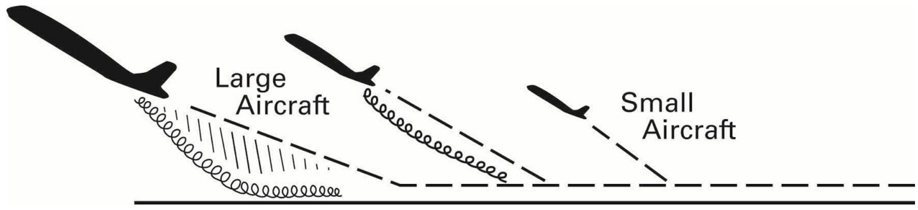


Figure 12: Departing behind a large aircraft - same runway.

Note the large aircraft's rotation point and rotate before it. Climb above and stay upwind of the large aircraft's climb path until turning clear of its wake.

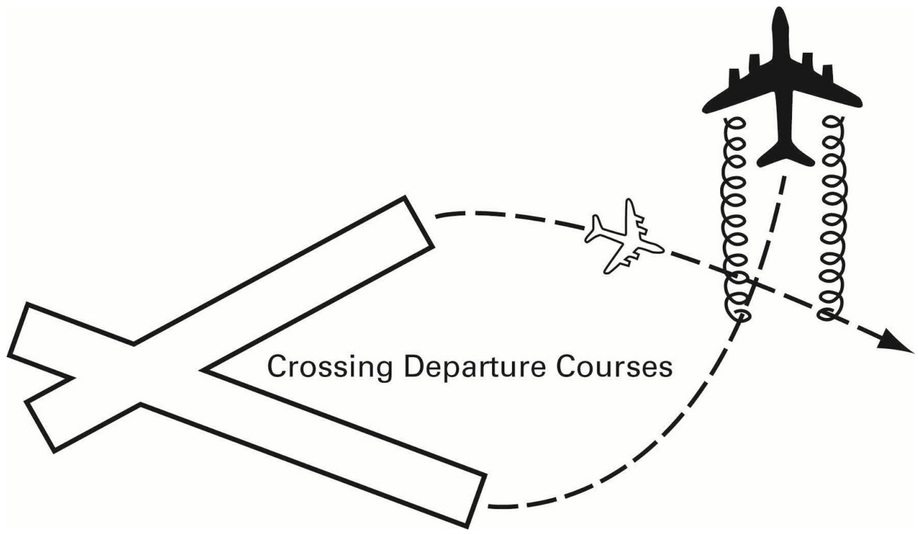


Figure 13: Departing behind a large aircraft - different runway.

When departing from a crossing runway, note the large aircraft's rotation point. If it is before the intersection, give sufficient time for the disturbance to dissipate before commencing take-off. Avoid headings that will cross behind and below a large aircraft after take-off.

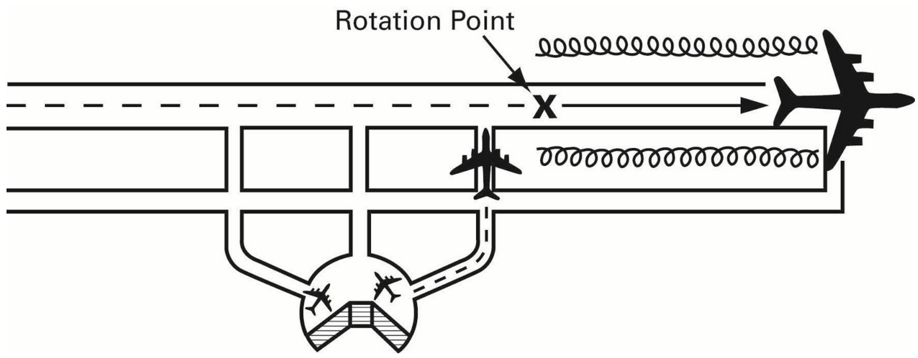


Figure 14: Take-off from an intersection along the same runway.

A vortex hazard may exist for about 2 minutes along a runway after a large aircraft has executed a low missed approach or a touch-and-go landing, particularly in light quartering wind conditions.

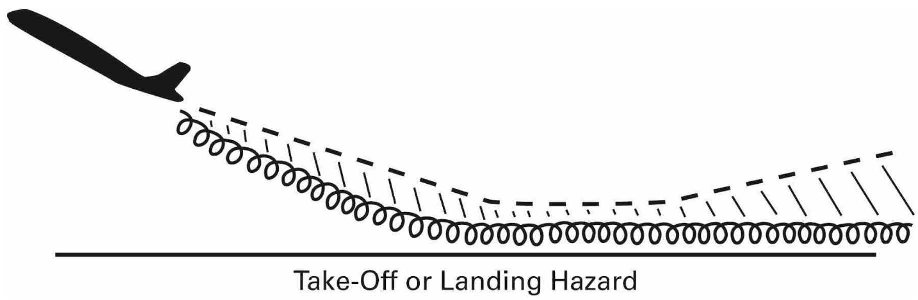


Figure 15: Departing or landing after a large aircraft executing a low missed approach or a touch-and-go landing.

A vortex hazard may exist for about 2 minutes along a runway after a large aircraft has executed a low missed approach or a touch-and-go landing, particularly in light quartering wind conditions.

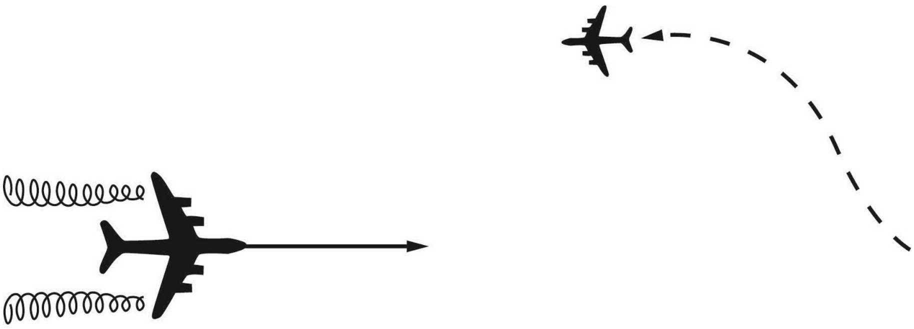

Figure 16: En-route in VMC.

## 5 Helicopters

5.1 In forward flight the downwash from the main rotor(s) of a helicopter is transformed into a pair of trailing vortices similar to the wingtip vortices of a fixed-wing aircraft (Figure 2). There is evidence that per kilogram of gross weight, these vortices are more intense than those of fixed-wing aircraft. The initial acceleration manoeuvre into forward flight, the landing 'flare' and air taxiing may generate higher rotor wash velocities than those produced in a stabilised hover.

5.2 When hovering, or whilst air taxiing, a helicopter directs a forceful blast of air downwards that then rolls outwards in all directions. This can create problems on the apron, in parking areas and to light aircraft movement on taxiways and runways. In particular there is a risk of damage to fixed-wing control runs and surfaces caused by helicopter downwash driving unlocked control surfaces forcibly against their stops. The risk of damage from this form of turbulence and from wake turbulence encounters may be reduced if the guidelines below are followed:

(a) wherever possible and/or practicable segregate helicopter movements from fixed wing movements;

(b) whenever possible, ground taxi rather than air taxi;

**Note:** Ground taxiing uses less fuel than air taxiing and minimises air turbulence. Hovering helicopter downwash turbulence, when produced in ground effect, has an increased horizontal flow; this increases proportionally with larger and heavier helicopters.

(c) if it is necessary to air taxi, ensure that as wide a clearance as possible is maintained from other aircraft or loose ground equipment;

(d) when air taxiing, avoid flying over parked aircraft or vehicles;

(e) when helicopters and fixed wing aircraft must use common areas such as aprons, it is recommended that helicopters follow standard taxi routes in those areas. This will facilitate any following aircraft to visualise avoidance areas or areas of increased likelihood of wake turbulence encounter.

5.3 Pilots of light aircraft should avoid operating within three rotor diameters of any helicopter in a slow hover taxi or stationary hover (Figure 17). As a visual indicator: if the skids / wheels of the helicopter are resting on the surface then the helicopter will be producing a much reduced downwash. Caution should be exercised however since the helicopter may lift into the hover with little or no notice, thus increasing downwash significantly.

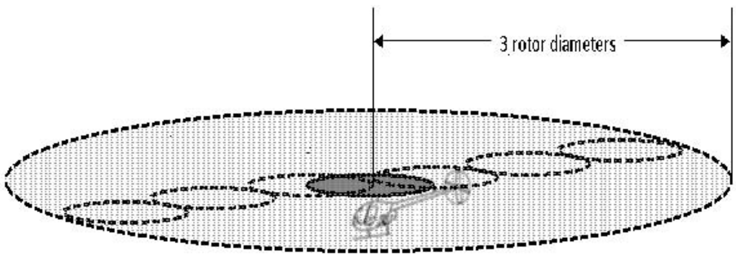


Figure 17*: Helicopter hover or slow hover taxi, 3-rotor diameter avoidance area.

***Note:*** ** Reference: Phillips, C. and Brown, R. E., 'Eulerian Simulation of the Fluid Dynamics of Helicopter Brownout'. American Helicopter Society 64th Annual Forum, Montreal, Canada, April 29 - May 1, 2008. *Reference: D'Andrea A., 'Numerical Analysis of Unsteady Vortical Flows Generated by a Rotorcraft Operating on Ground: a First Assessment of Helicopter Brownout'. 65th AHS Annual Forum, Grapevine, Texas, May 27-29, 2009. *Reference: Modha A. N., Blaylock T. A. and Chan W. Y. F. 'Brown-out - Flow Visualisation using FLUENT® VBM'. International Aerospace CFD Conference, Paris, June 18 - 19 2007. *Reference: Devi Prasad Pulla, 'A study of helicopter aerodynamics in ground effect'. Dissertation for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University, Ohio State University, 2006.*

5.4 Pilots of light aircraft should use caution when operating behind or crossing behind landing and departing helicopters.

5.5 At events where a large number of helicopters of varying sizes are hovering in close proximity to one another care must be taken to ensure that power and control limits are not exceeded due to the downwash produced by adjacent aircraft.

5.6 Controllers and pilots should consider wake vortices generated when helicopters hover taxi across active runways and apply the appropriate wake turbulence separation minima. Caution should be exercised when a helicopter or fixed-wing aircraft of lower weight category is cleared to land on a runway immediately after a helicopter of higher weight category has taken off from that runway's threshold. Additionally it should be borne in mind that the downwash and associated turbulence generated by a hovering helicopter can drift a substantial distance downwind and may therefore affect an adjacent runway.

5.7 In cruise flight, light fixed-wing aircraft should allow a substantial horizontal distance when passing behind and below helicopters, which may produce greater than expected wake turbulence.

5.8 Helicopters should not hold in the hover within 3 rotor diameters of an active runway where the vortex may be transported to the runway thereby increasing the risk of wake vortex encounter to aircraft using the runway.

## 6 Wake Turbulence Encounter Reporting and Research

6.1 A Report Form is available to download from the CAA website as follows:

Wake Turbulence Report Form: http://www.caa.co.uk/SRG1423

Full instructions for submitting the form are contained on the form.

This form is for use by pilots and ATCOs to report a wake turbulence encounter in any phase of flight, including those hazardous cases that qualify as Reportable Occurrences under Article 226 of the Air Navigation Order 2009 and the EU Directive 2003/42. From 15 November 2015, with the entry into force of Regulation (EU) No 376/2014 'on reporting, analysis and follow-up of occurrences in civil aviation' the EU Directive 2003/42 will be repealed.

The report form may be used for all wake turbulence encounters or by aircraft generating wake turbulence

6.2 Pilots of aircraft believed to have created the wake turbulence will be informed by ATC and are requested to complete the appropriate sections of form SRG1423. The sections are identified on the form.

6.3 ATCO reporting procedures are contained in CAP 493 Manual of Air Traffic Services Part 1.

6.4 The reports received to date have been very valuable in obtaining a better understanding of the wake turbulence problem. They have facilitated an assessment of the effectiveness of the current standards in providing a satisfactory level of safety. The continued co-operation of pilots and controllers in making these reports is requested. Pilots are reminded that reports are required of wake turbulence encounters occurring behind any class of aircraft and during any phase of flight, eg en-route, climb and descent, as well as the approach and departure phases.

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