AERONAUTICAL INFORMATION CIRCULAR P 083/2020

UNITED KINGDOM

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WAKE TURBULENCE - EFFECTIVE 5 FEBRUARY

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 improvements to the UK's existing wake turbulence separation arrangements and to implement aspects of Amendment 9 to ICAO Doc 4444 PANS-ATM.

1.2 This Circular is intended for all airspace users and Air Navigation Service Providers (ANSPs). It incorporates the ICAO PANS-ATM requirements relating to aircraft in the SUPER wake turbulence category, and states the aircraft wake turbulence categories that are used by ANSPs in the UK to determine the required wake turbulence separation minima when sequencing aircraft in the approach and departure phase. This Circular also re-states the general warning on the characteristics of wake vortex 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 Sixteenth Edition 2016, Chapter 4 paragraph 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 Sixteenth Edition 2016, Chapter 4 paragraph 4.9.1.1.*

1.5 The United Kingdom has adopted the terminology as described in paragraphs 1.3 and 1.4, and this is reflected in the RTF phraseology.

2 Wake Turbulence Categories and Separation Criteria

2.1 Background

2.1.1 Wake turbulence separation minima are based on a grouping of aircraft types into categories, generally according to their maximum certificated take-off mass (MCTOM).

2.1.2 The United Kingdom conforms, in general, to the ICAO standards on wake turbulence. However, experience at those UK aerodromes where an air traffic control (ATC) service is provided and wake turbulence separation minima are applied, has shown that certain modifications to the relationship between the MCTOM of an aircraft and the wake turbulence separation are advisable for the safety of operations.

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

2.2.1 A modification to the thresholds between the MEDIUM and LIGHT wake turbulence categories and the introduction of a separate category (SMALL) for separation purposes (see paragraph 2.4).

2.2.2 Some enhancement of the wake turbulence separation minima between certain categories (see paragraphs 2.5.1 and 2.6.1).

2.2.3 In 1997 a further modification was made for the purpose of wake turbulence 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 where an air traffic control (ATC) service is provided and wake turbulence separation minima are applied.

2.2.4 In 2020, it was recognised that these modifications to the ICAO wake turbulence categories were not required for use at aerodromes where aerodrome flight information service (AFIS) was provided. The ICAO wake turbulence categories are utilised at AFIS aerodromes to determine whether a warning of the expected occurrence of hazards caused by turbulent wake should be provided (see paragraph 2.15).

2.2.5 Also in 2020, ICAO issued Amendment 9 to ICAO Doc 4444 PANS-ATM which introduced the SUPER wake turbulence category and the associated separation minima that had previously been detailed within ICAO State Letter TEC/OPS/SEP – 08-0294.SLG of 8 July 2008.

2.3 Composition of Flight Plans

2.3.1 Differences between the ICAO and UK wake turbulence categories do not affect the composition of flight plans, which should be completed in accordance with ICAO Doc 4444 PANS-ATM and UK AIP ENR 1.10. The aircraft's wake turbulence category should be entered on the flight plan (item 9) as J, H, M or L according to the ICAO wake turbulence categories below (see paragraph 2.4).

2.3.2 For aircraft in the SUPER or HEAVY wake turbulence categories, the word "super" or "heavy" shall be included, as appropriate, immediately after the aircraft callsign in the initial RTF contact between such aircraft and ATS units.

2.4 Wake Turbulence Categories (MCTOM in KG)

2.4.1 The UK wake turbulence categories are adapted from those of ICAO. In the UK, aircraft are divided into six categories for approach, and five categories for departure, according to their MCTOM in KG as described below.

2.4.2 Aeroplanes

Wake Turbulence Category	ICAO (KG)	UK Departures (KG)	UK Arrivals (KG)
Super (J)	≥ 136,000	≥ 136,000	≥ 136,000
Heavy (H)	≥ 136,000	≥ 136,000	≥ 136,000
Medium (M)	> 7,000 & < 136,000	> 40,000 & < 136,000	N/A
Upper Medium (UK only)	N/A	N/A	> 104,000 & < 136,000
Lower Medium (UK only)	N/A	N/A	> 40,000 & ≤ 104,000
Small (S) (UK only)	N/A	> 17,000 & ≤ 40,000	> 17,000 & ≤ 40,000
Light (L)	≤ 7,000	≤ 17,000	≤ 17,000

2.4.3 Helicopter and tilt-rotor aircraft

Wake Turbulence Category	ICAO (KG)	UK Departures (KG)	UK Arrivals (KG)
Medium (M)	> 7,000 & < 136,000	> 40,000 & < 136,000	N/A
Upper Medium (UK only)	N/A	N/A	> 104,000 & < 136,000
Lower Medium (UK only)	N/A	N/A	> 40,000 & ≤ 104,000
Small (S) (UK only)	N/A	≥ 7,000 & ≤ 40,000	≥ 7,000 & ≤ 40,000
Light (L)	≤ 7,000	< 7,000	< 7,000

2.4.4 The UK UPPER MEDIUM and LOWER MEDIUM categories are considered to form the MEDIUM wake turbulence category and is not split for wake turbulence separation on departure.

2.4.5 UPPER MEDIUM, LOWER MEDIUM and SMALL are UK categories only, and are not to be entered onto the flight plan under item 9.

2.4.6 Certain aircraft have wake turbulence generation and resistance characteristics which differ from those which would be expected based upon their MCTOM alone, and this affects their categorisation. There is some evidence that, per KG of gross mass, the wake turbulence generated by a helicopter is more intense than that of a fixed-wing aircraft. Consequently, in the UK, all helicopters with a MCTOM of 7,000 KG or more and 40,000 KG or less are classified as SMALL for the purposes of providing wake turbulence separation on approach and departure.

2.4.7 The operational characteristics of tilt-rotor aircraft in the final approach and departure phases of flight are akin to a helicopter, rather than an aeroplane. Consequently, in the UK, all tilt-rotor aircraft with a MCTOM of 7,000 KG or more and 40,000 KG or less are classified as SMALL for the purposes of providing wake turbulence separation on approach and departure.

2.4.8 The SUPER wake turbulence category is only assigned to specific aircraft types by the competent authority, with types assigned to this category warranting specific wake turbulence separation minima. Types assigned to the SUPER wake turbulence category by the UK CAA are the Airbus A380-800, the Antonov AN-124 Ruslan and the Antonov AN-225 Mriya. Apart from the additional wake turbulence separation minima identified, aircraft within the SUPER category shall be treated as a HEAVY category aircraft in all other circumstances.

2.5 Wake Turbulence Separation Minima - Final Approach

2.5.1

Leading Aircraft	Following Aircraft	Wake Tubulence Seperation Minima Distance (NM)	
		ICAO	UK
SUPER	SUPER	#	#
SUPER	HEAVY	5	5
SUPER	UPPER & LOWER MEDIUM	7*	7*
SUPER	SMALL	N/A	7
SUPER	LIGHT	8	8
HEAVY	SUPER	#	#
HEAVY	HEAVY	4	4
HEAVY	UPPER & LOWER MEDIUM	5*	5
HEAVY	SMALL	N/A	6
HEAVY	LIGHT	6	7
UPPER MEDIUM	SUPER	#	#
UPPER MEDIUM	HEAVY	#	#
UPPER MEDIUM	UPPER MEDIUM	N/A	3
UPPER MEDIUM	LOWER MEDIUM	N/A	4
UPPER MEDIUM	SMALL	N/A	4
UPPER MEDIUM	LIGHT	5	6
LOWER MEDIUM	SUPER	#	#
LOWER MEDIUM	HEAVY	#	#
LOWER MEDIUM	UPPER MEDIUM	N/A	#
LOWER MEDIUM	LOWER MEDIUM	N/A	#
LOWER MEDIUM	SMALL	N/A	3
LOWER MEDIUM	LIGHT	5	5
SMALL	SUPER	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	SUPER	#	#
LIGHT	HEAVY	#	#
LIGHT	UPPER MEDIUM	#	#
LIGHT	LOWER MEDIUM	#	#
LIGHT	SMALL	#	#
LIGHT	LIGHT	#	#

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

2.5.2 Unless alternative wake turbulence separation criteria have been approved for use, the UK wake turbulence separation minima specified in 2.5.1 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)

2.6 Wake Turbulence Separation Minima – Departures

2.6.1 The UK does not split the MEDIUM wake turbulence category for the purposes of wake turbulence separation on departure.

<table>
<tr><th>Leading Aircraft</th><th>Following Aircraft</th><th colspan="2">Minimum Wake Turbulence Separation at the Time Aircraft are Airborne</th></tr>
<tr><td>SUPER</td><td>SUPER</td><td rowspan="6">Departing from the same position

or

from a parallel runway separated by less than 760 M (2500 FT)</td><td>No wake turbulence separation minima required*</td></tr>
<tr><td rowspan="2">SUPER</td><td>HEAVY</td><td>2 minutes</td></tr>
<tr><td>MEDIUM
SMALL
LIGHT</td><td>3 minutes</td></tr>
<tr><td>HEAVY</td><td>HEAVY</td><td>4 NM or time equivalent</td></tr>
<tr><td>HEAVY</td><td>MEDIUM
SMALL
LIGHT</td><td>2 minutes</td></tr>
<tr><td>MEDIUM OR SMALL</td><td>LIGHT</td><td>2 minutes</td></tr>
</table>

Leading Aircraft	Following Aircraft	Minimum Wake Turbulence Separation at the Time Aircraft are Airborne	
SUPER	SUPER	Departing from an intermediate point on the same runway or from an intermediate point of a parallel runway separated by less than 760 M (2500 FT)	No wake turbulence separation required*
SUPER	HEAVY		3 minutes
	MEDIUM SMALL LIGHT		4 minutes
HEAVY (Full length take-off)	HEAVY		4 NM or time equivalent
	MEDIUM SMALL LIGHT		3 minutes
MEDIUM or SMALL (Full length take-off)	LIGHT		3 minutes

2.6.2 Unless alternative wake turbulence separation criteria have been approved for use, the UK wake turbulence separation minima specified in 2.6.1 apply when the aircraft are using:

a) the same runway; or

b) parallel runways separated by less than 760 M (2500 FT); or

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; or

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.

2.6.3 Wake turbulence separation 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.

2.6.4 Pilots do, on occasion, request departure clearance before the minimum time separation has elapsed. On those occasions ATC will 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.

2.7 Wake Turbulence Separation Minima - Displaced Landing Threshold

2.7.1 When operating a displaced landing threshold, the following minimum wake turbulence separations will be applied if the projected flight paths are expected to cross:

a) A departing HEAVY aircraft following a SUPER aircraft arrival – 2 minutes;

b) A departing LIGHT, SMALL or MEDIUM aircraft following a SUPER aircraft arrival – 3 minutes;

c) A departing LIGHT, SMALL or MEDIUM aircraft following a HEAVY aircraft arrival – 2 minutes;

d) A departing LIGHT aircraft following a SMALL or MEDIUM (LOWER and UPPER) aircraft arrival – 2 minutes;

e) A HEAVY aircraft arrival following a SUPER aircraft departure – 2 minutes;

f) A LIGHT, SMALL or MEDIUM (LOWER and UPPER) aircraft arrival following a SUPER aircraft departure – 3 minutes;

g) A LIGHT, SMALL or MEDIUM (LOWER and UPPER) aircraft arrival following a HEAVY aircraft departure – 2 minutes;

h) A LIGHT aircraft arrival following a SMALL or MEDIUM aircraft departure – 2 minutes.

2.8 Wake Turbulence Separation Minima - Opposite Direction

2.8.1 For a heavier aircraft making a low or missed approach and when the lighter aircraft is:

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

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

c) landing on a parallel opposite-direction runway separated by less than 760 M (2500 FT).

the following minimum separations shall be used:

d) between a HEAVY aircraft and a SUPER aircraft – 3 minutes;

e) between a LIGHT, SMALL or MEDIUM (LOWER & UPPER) aircraft and a SUPER aircraft – 4 minutes;

f) between a LIGHT, SMALL or MEDIUM (LOWER & UPPER) aircraft and a HEAVY aircraft – 3 minutes;

g) between a LIGHT aircraft and a SMALL or MEDIUM (LOWER and UPPER) aircraft – 3 minutes.

2.9 Wake Turbulence Separation Minima - Crossing and Parallel Runways

2.9.1 When parallel runways separated by less than 760 M are in use, such runways are considered to be a single runway for wake turbulence separation purposes, and the wake turbulence minima listed in paragraphs 2.5.1 and 2.6.1 apply to landing and departing aircraft respectively.

2.9.2 The wake turbulence separation minima listed in paragraph 2.6.1 will apply to:

a) Departures from crossing and/or diverging 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;

b) departures from parallel runways more than 760 M (2500 FT) apart, 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.

2.10 **Wake Turbulence Separation Minima - Intermediate Approach**

2.10.1 The intermediate approach segment is defined as that segment of an instrument approach procedure between either the intermediate approach fix and the final approach fix or point, or between the end of a reversal, racetrack or dead reckoning track procedure and the final approach fix or point, as appropriate.

2.10.2 The intermediate phase of an approach is associated with each specific Instrument Approach Procedure and airport. Therefore, each airport or terminal area will define the area or portion of a procedure where the intermediate approach wake turbulence separation minima apply.

2.10.3 Unless alternative wake turbulence separation criteria have been approved for use, the following wake turbulence separation minima will be applied in the intermediate approach segment:

a) 5 NM between a HEAVY (excluding a SUPER) aircraft and a MEDIUM (UPPER & LOWER) or SMALL aircraft following or crossing behind at the same level or less than 1000 FT below;

b) 6 NM between a HEAVY (excluding a SUPER) aircraft and a LIGHT aircraft following or crossing behind at the same level or less than 1000 FT below;

c) As per the final approach wake turbulence separation minima for aircraft following or crossing behind a SUPER aircraft at the same level or less than 1000 FT below (see paragraph 2.5.1).

2.11 **Wake Turbulence Separation Minima – Time Based Separation (TBS) for Final Approach[5]**

2.11.1 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.

2.11.2 Time Based Separation (TBS) is the application of time-based wake turbulence separation minima on final approach.

2.11.3 TBS manages the risk of wake turbulence encounter by taking account of turbulent decay of wake vortices at lower altitudes due to medium and strong headwinds. TBS minima 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.

2.11.4 The TBS minima provide consistent time separation which are equivalent to the existing distance-based separation minima (see paragraph 2.5.1) 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 minima are applied by controllers using the same practices and procedures as distance-based wake turbulence separation. Application of TBS minima makes use of controller tool support indicators, in order that the controller can visualise time separation on a controller's surveillance system display.

2.11.5 An enhanced version of TBS (eTBS) has been developed which uses wake turbulence categories and separation minima detailed in RECAT-EU. RECAT-EU is a re-categorisation of the wake turbulence separation minima prescribed by ICAO and is described in EUROCONTROL document "RECAT-EU European Wake Turbulence Categorisation and Separation Minima on Approach and Departure".

2.11.6 Where eTBS is deployed for approach, RECAT-EU separation minima are applicable on intermediate approach.

2.12 **Wake Turbulence Separation Minima – RECAT- EU Departure Separations**

2.12.1 Where approved for use, RECAT-EU departure separation minima may apply. These use a different wake turbulence categorisation and minima to those described in paragraph 2.6 and, in many cases, provide for a reduced time separation. For further information, RECAT-EU is described in EUROCONTROL document "RECAT-EU European Wake Turbulence Categorisation and Separation Minima on Approach and Departure".

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 carrying out a touch-and-go or low approach 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 AIC cannot entirely remove the possibility of a wake turbulence encounter (see section 6 on reporting and 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 a SUPER 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 e.g. 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.

2.15 **Wake Turbulence warnings at AFIS Aerodromes**

2.15.1 AFIS means flight information service for aerodrome traffic and as such provides advice and information useful for the safe and efficient conduct of flights in the vicinity of an aerodrome. Whilst the responsibility for wake turbulence avoidance rests entirely with the pilot-in-command, AFIS shall, to the extent practicable, provide a warning of the expected occurrence of hazards caused by turbulent wake to:

a) arriving flights making an approach to the same runway as an immediately preceding aircraft of a higher wake turbulence category; and

b) departing flights taking-off from the same runway as an immediately preceding aircraft of a higher wake turbulence category.

2.15.2 AFIS units will use the ICAO wake turbulence categories (see paragraph 2.4) in applying the criteria in 2.15.1(a) and (b) above.

2.15.3 The occurrence of wake turbulence hazards cannot be accurately predicted and AFIS units cannot assume responsibility for the issuance of information on such hazards at all times, nor for its accuracy.

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).

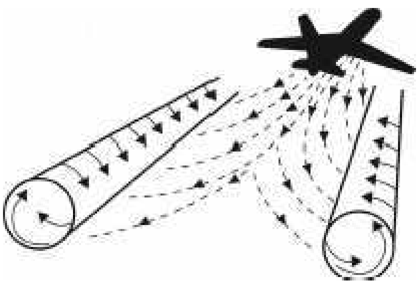

Figure 1: General View of Aircraft Trailing Vortex System.

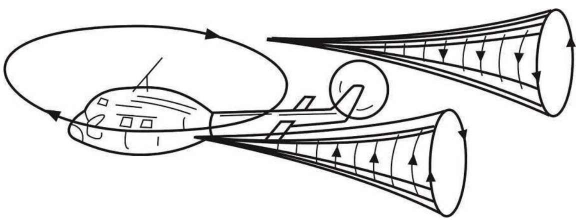

Figure 2: Helicopter Vortices.

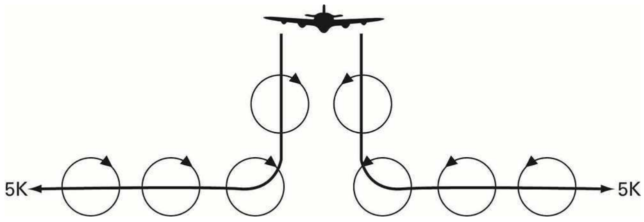

Figure 3: Vortex movement near the ground in still air, viewed from behind the generating aircraft.

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.

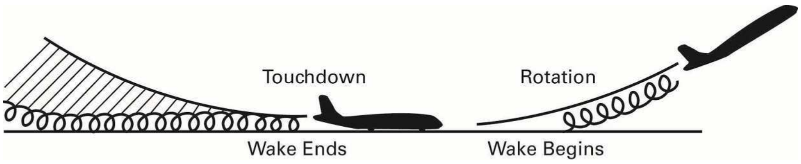

Figure 4: Vortex generation in the landing and take-off phases of flight.

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.

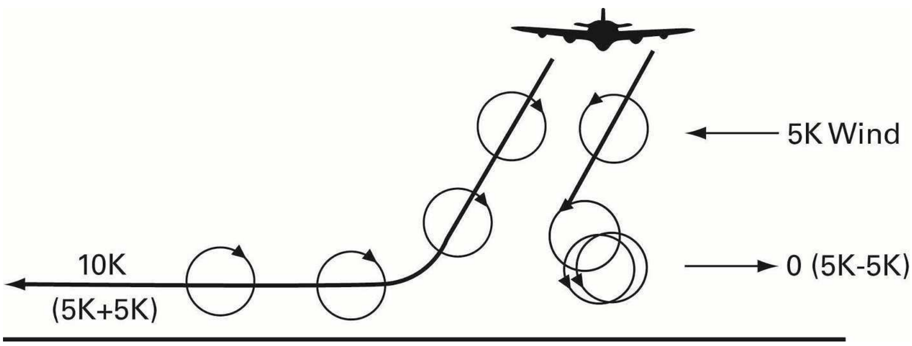

Figure 5: Vortex movement near the ground in a light crosswind, viewed from behind the generating aircraft.

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 take-off 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 section 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 section 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 environment.

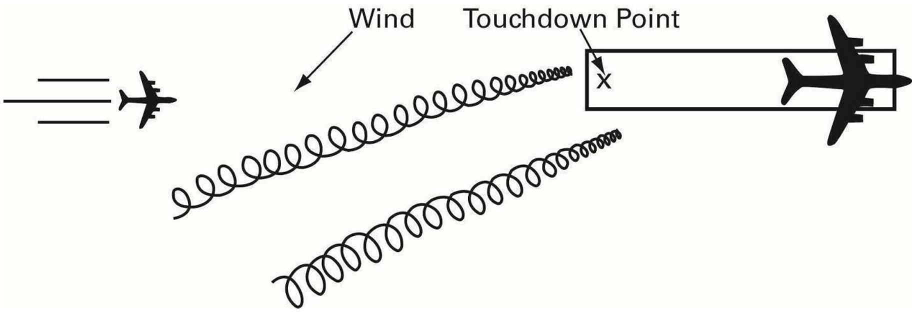

Figure 6: Landing behind a large aircraft on the same runway.

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

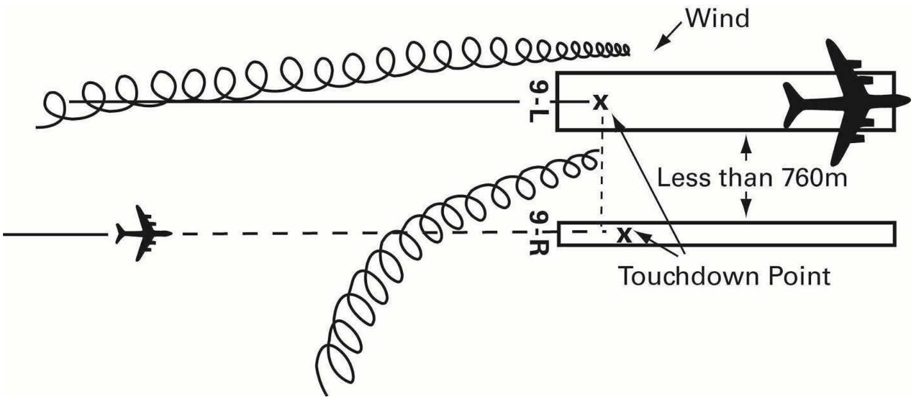

Figure 7: landing behind a large aircraft on a parallel runway when the parallel runway is closer than 760 M. Consider possible drift to the runway. Stay at or above the large aircraft's final approach path and observe its touchdown point.

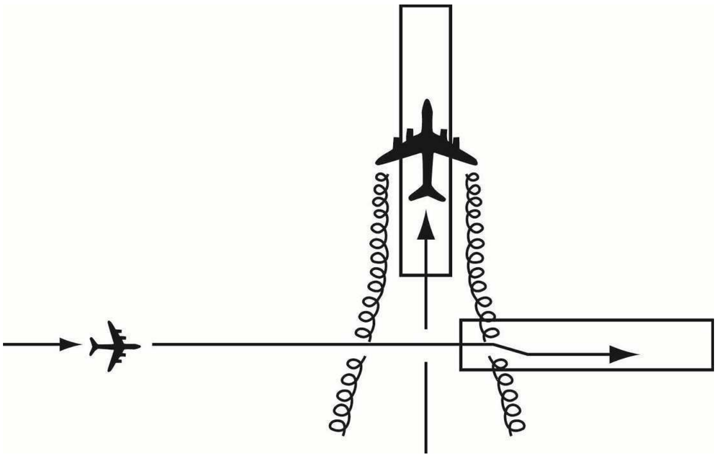

Figure 8: Landing behind a large aircraft - crossing runway. Cross above the large aircraft's flight plan.

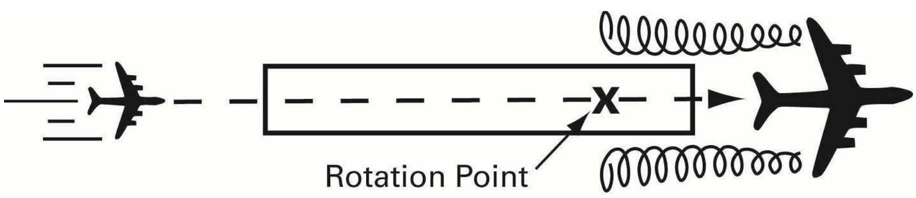

Figure 9: Landing behind a departing large aircraft - same runway.

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

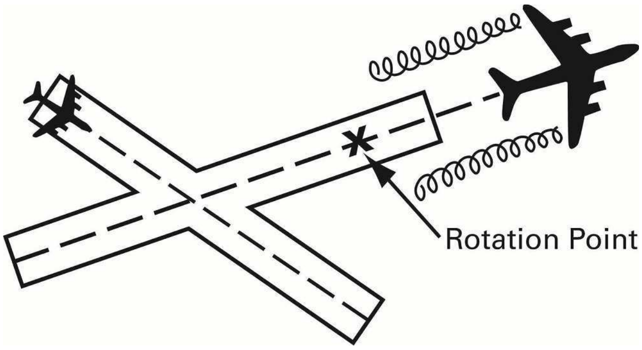

Figure 10: Rotation point beyond the intersection.

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

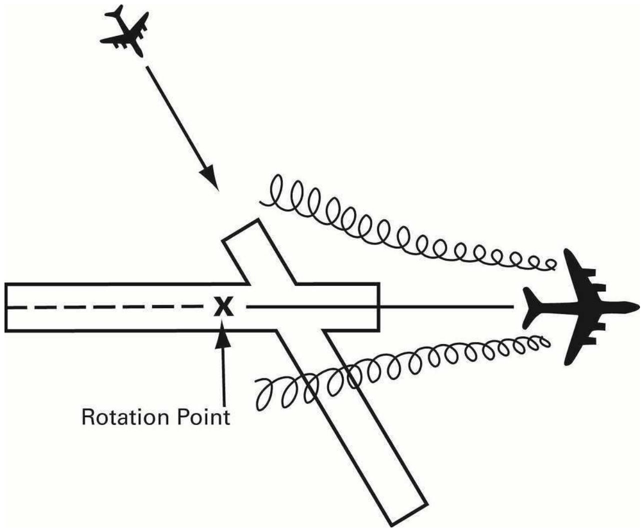

Figure 11: Rotation point prior to intersection.

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.

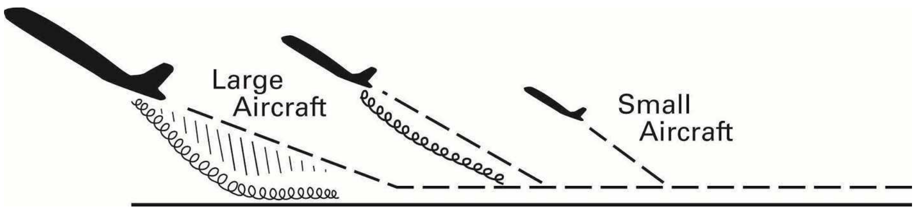

Figure 12: Departing behind a large aircraft - same runway.

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.

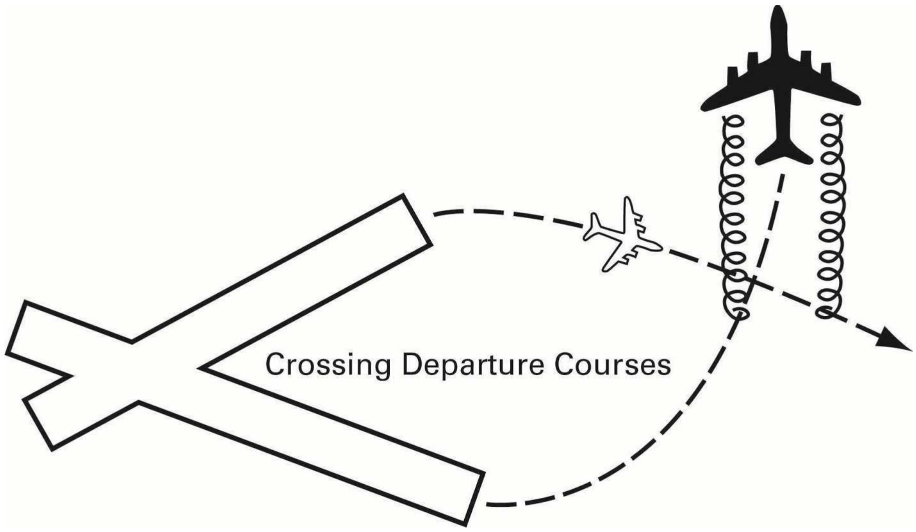

Figure 13: Departing behind a large aircraft - different runway.

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. Avoiding headings that will cross behind and below a large aircraft after take-off.

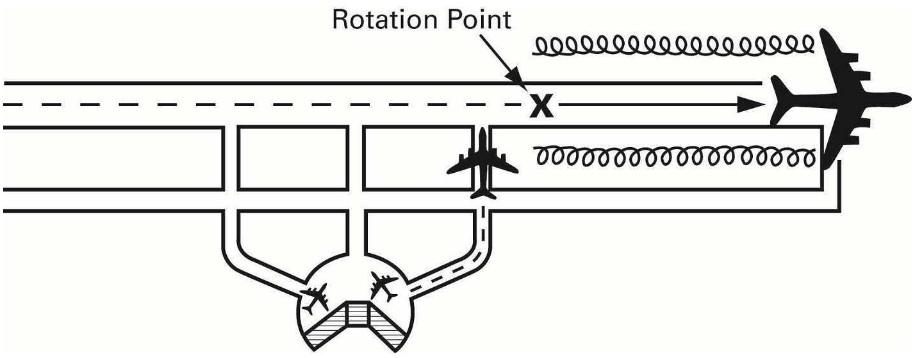

Figure 14: Take-off from an intersection along the same runway.

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.

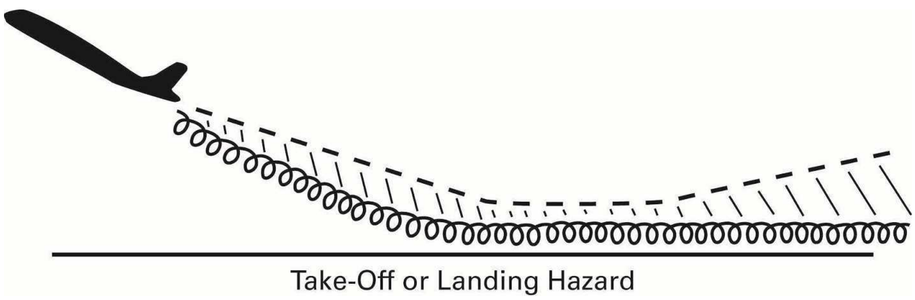

Figure 15: Departing or landing after a large aircraft executing a low missed approach or a touch-and-go landing.

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.

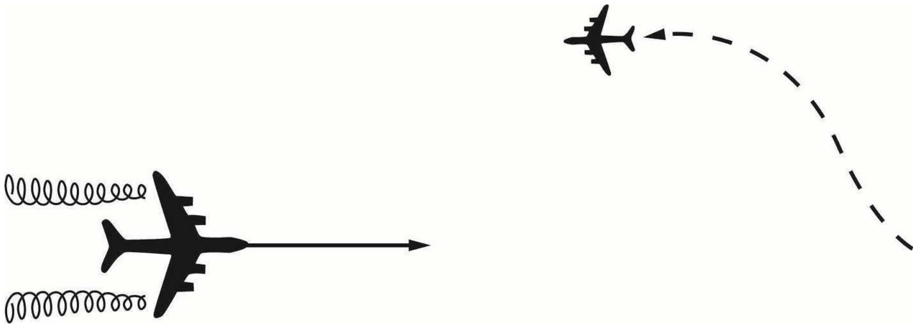

Figure 16: En-route in VMC.

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 KG 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.

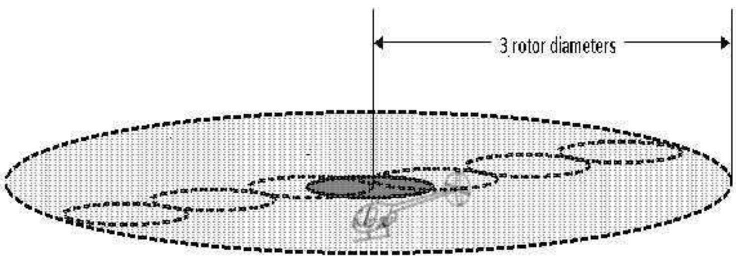

Figure 17*: Helicopter hover or slow hover taxi, 3-rotor diameter avoidance area.

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 Regulation (EU) No 2015/1018 lays down a list of classifying occurrences in civil aviation which are subject to mandatory occurrence reporting in accordance with Regulation (EU) No 376/2014 Article 4(1), based on the significant risk that they pose to aviation safety. Regulation (EU) No 2015/1018 Annex 1 5(7) classifies wake-turbulence encounters as a mandatorily reportable occurrence.

6.2 Pilots of aircraft that have encountered wake turbulence should report the occurrence through either their organisation’s ECCAIRS/ADREP compatible safety reporting system or directly via the EU Reporting Portal available at http://www.aviationreporting.eu/AviationReporting/.

Note: *For more information on ECCAIRS/ADREP compatible safety reporting systems and the EU Reporting Portal, see CAP 382 Mandatory Occurrence Reporting Scheme.*

6.3 Pilots of aircraft that are believed to have created the wake turbulence will be informed by ATC and are requested to complete a mandatory occurrence report in order to provide additional material to better understand the wake turbulence encounter.

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

6.5 The reports received to date have been very valuable in obtaining a better understanding of the wake turbulence problem and safety analysis has been significantly enhanced when supplemented with digital flight data from the affected aircraft. 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 it is mandatory to report 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. In reporting such occurrences, pilots are requested to include within the narrative section of the report the altitude and location of the event, a description of the effect on the aircraft including the induced bank angle and their assessment of the severity of the event.