WAKE TURBULENCE
HAZARDS AND CHARACTERISTICS

1. INTRODUCTION

1.1 Every heavier-than-air aircraft generates wake turbulence whilst in flight as a by-product of lift creation. The wake consists of two counter-rotating cylindrical vortices, the strength of which is governed by the weight, speed, and wing shape of the generating aircraft. These vortices' strength is greatest when the generating aircraft is heavy, clean and slow.

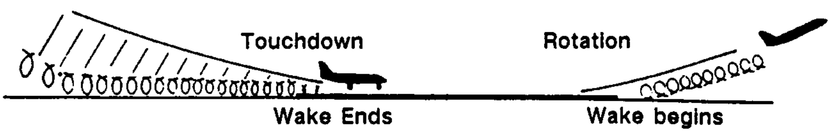
1.2 This advice provides general information and guidance to pilots concerning aircraft wake turbulence.

2. HAZARDS AND CHARACTERISTICS

2.1 The primary hazard resulting from a wake encounter is induced roll. Wake-induced rolling moment can exceed the countering capability of the encountering aircraft, with catastrophic results if close to the ground.

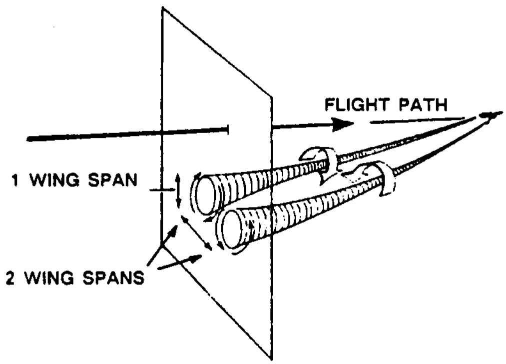
2.2 Structural damage can also be inflicted by such vortices. The capability of an aircraft to counteract these rolling moments depends on its wing span and counter-control responsiveness. The countering control is usually effective, and induced roll minimal, where the wing span and ailerons of the encountering aircraft extend beyond the rotational diameter of the vortex. Aircraft with a short wing span have more difficulty in countering such rolling moments, and pilots of such aircraft (even high performance types) should be particularly careful to avoid such encounters. <u>The wake from large aircraft requires the respect of all pilots</u>.

2.3 Wake turbulence generation begins at rotation and ends at touchdown. Prior to touchdown or take-off, pilots of following aircraft should note the touchdown or lift-off point of the leading aircraft.



Wake Vortex Generation

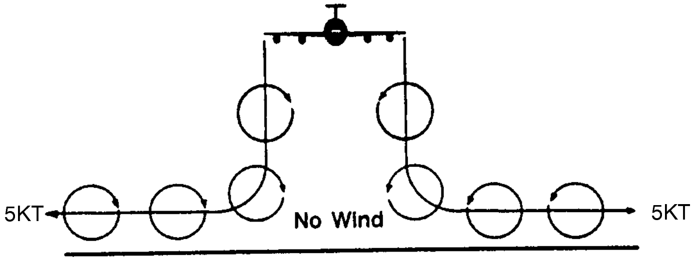
2.4 In cross-section, the vortex field flow covers an area about two wing spans in width and one wing span in height. The vortices tend to maintain this spacing, drifting with the wind, at altitudes greater than about a wing span from the ground. If persistent wake turbulence is encountered en route, a small change in height or lateral position (preferably upwind) will provide a flight path clear of the wake.



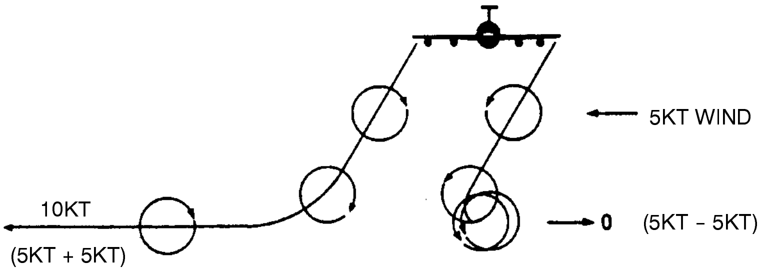
Wake Vortex Dimensions

2.5 Vortices tend to sink at a rate of about 400-500FT/MIN, and then to level off at about 900FT below the flight path of the generating aircraft. Pilots should therefore aim to fly at or above a preceding large aircraft's flight path. <u>The area behind and below the aircraft should be avoided, particularly at low altitude</u>.

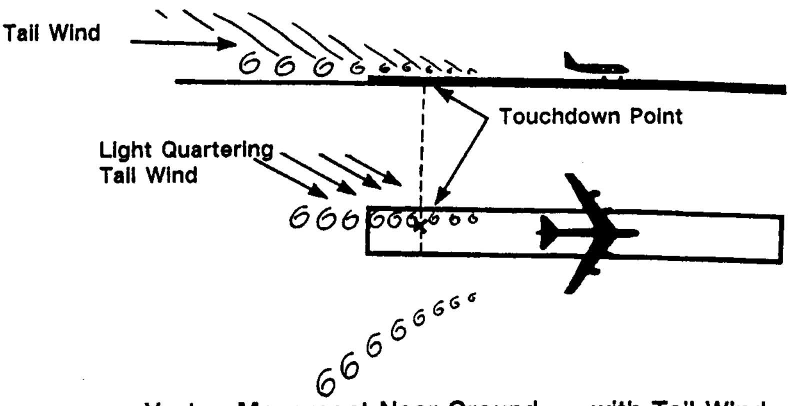
2.6 When the vortices of large aircraft sink close to the ground (within about 200FT), they tend to move laterally over the ground at about 5KT. A crosswind will decrease the lateral movement of the windward vortex and increase the movement of the leeward vortex. Therefore, a light wind of 3-7KT is dangerous because it could result in the upwind vortex remaining in the touchdown zone for a significant period of time. Similarly, a tailwind may move the vortices of the preceding aircraft forward beyond the touchdown zone. Consequently, light crosswinds and quartering tailwinds require the utmost caution. <u>Pilots should be alert to large aircraft upwind of their approach or take-off flight paths and adjust their own flight paths accordingly</u>.



Vortex Movement Near Ground - No Wind



Vortex Movement Near Ground - with Cross Wind



Vortex Movement Near Ground - with Tail Wind

2.7 Atmospheric conditions can result in vortices:

a. remaining in the touchdown area;

b. drifting from aircraft operating on a nearby runway;

c. sinking into the take-off or landing path from a crossing runway;

d. sinking into the traffic pattern from other aerodrome operations; or

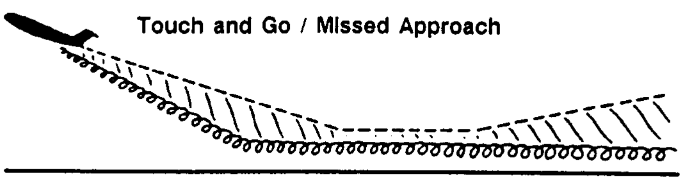
e. sinking into the flight path of aircraft operating or crossing 500FT below when en route.

2.8 Using the diagrams in this advice as a guide, pilots should visualise the location of vortices behind large aircraft and try to avoid them, thus minimising risk and enhancing operational safety. Similarly, where practicable, pilots of large aircraft should plan their flight paths to minimise exposing other aircraft to their vortices.

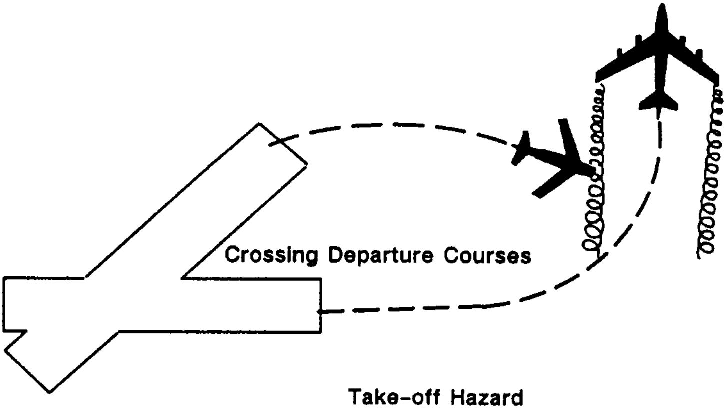
2.9 In stable conditions, wake vortices can exist for a period in excess of three minutes. Even where wake turbulence separation standards are applied, a wake encounter may still occur. However, the objectives of these standards are to reduce the probability of an encounter, and to minimise the magnitude of its effects should an encounter occur. Atmospheric turbulence and high winds close to the ground hasten the decay and disintegration of the vortices.

Large Aircraft

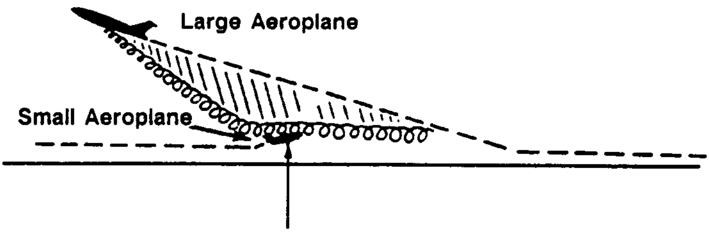
Touch and Go / Missed Approach



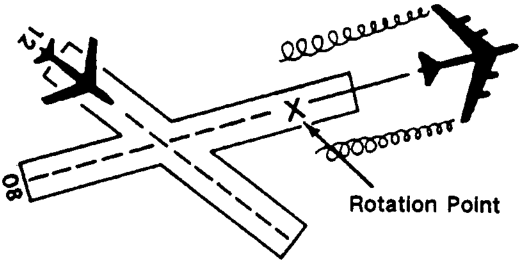
Take-off or Landing Hazard



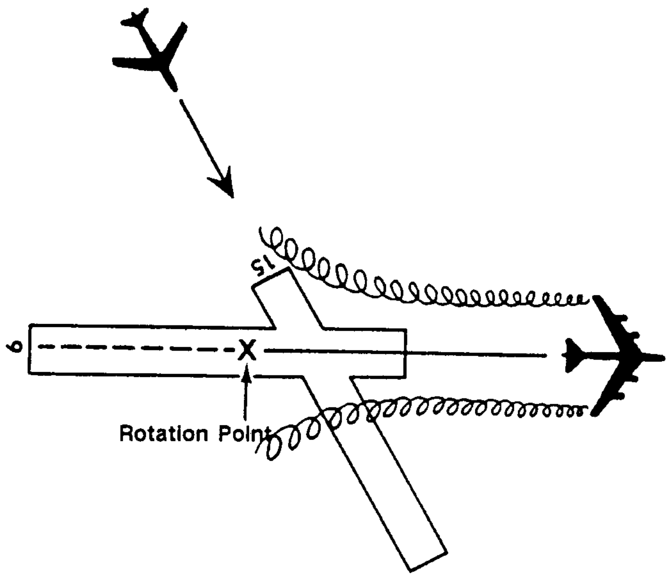
Take-off Hazard



Critical Take-off Situation



No Landing Hazard due to Wake Turbulence (But see Section 4)

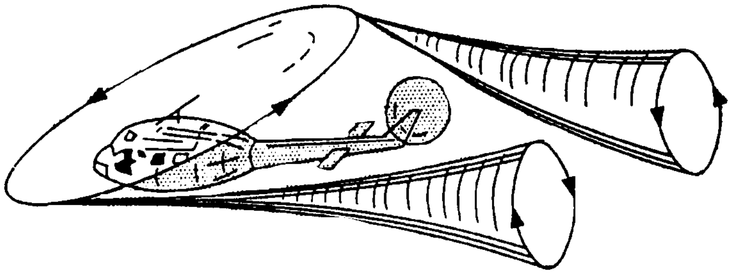


Landing Hazard

2.10 Pilots of small aircraft should be aware that Heavy and Medium aircraft at light weights are capable of steep climb gradients. Thus, although their aeroplane may become airborne well before the lift-off point of a leading larger aircraft, the subsequent flight path, being shallower, may pass through the larger aircraft's wake.

3. HELICOPTER VORTICES

3.1 Helicopters in forward flight produce vortices similar to those produced by fixed-wing aircraft, and evidence suggests that, weight for weight, helicopter vortices may be more significant than those from fixed-wing aircraft. A hovering or slow air-taxiing helicopter creates a rotor downwash which can be a hazard to a distance about three times the diameter of the rotor. Therefore, pilots of small aircraft should avoid operating in this area, and pilots of helicopters should maintain at least a three-rotor-diameter distance from parked or taxiing aircraft.



Helicopter Wake Vortices

4. THRUST STREAM TURBULENCE

4.1 Whilst wake turbulence does not commence until lift is being created, large jet engines can produce significant turbulence behind them when operated at high thrust settings. As a guide, fast-moving turbulent air can extend approximately 600M behind a DC10, 500M behind a B747 and 180M behind a B727. Pilots, particularly of small aircraft, should therefore take care not to line-up, take-off. or land too closely behind a departing large aircraft using the same, or intersecting, runway.

END