WAKE VORTEX TURBULENCE

Throughout the world, many thousands of wake vortex incidents occur every year. Thankfully, these incidents are seldom serious, although they are often very frightening to passengers and crew and may result in injuries to persons who are not strapped in, or if loose articles are thrown about the cabin. IFALPA[4] considers Wake Vortex to be a seriously under-reported issue.

A few fatal accidents have been attributed, directly or indirectly, to wake turbulence. The most recent of these involved the loss of American Airlines Flight 587, a summary of which follows.

American Airlines Flight 587

On November 12, 2001, American Airlines flight 587, an Airbus A300, crashed into a residential area of Belle Harbour, New York, shortly after takeoff from John F. Kennedy International Airport New York. Flight 587 was a scheduled passenger flight with 2 flight crew members, 7 flight attendants, and 251 passengers on board. The airplane's vertical stabilizer and rudder separated in flight and were found in Jamaica Bay, about 1 mile north of the main wreckage site. The airplane's engines subsequently separated in flight and were found several blocks north and east of the main wreckage site. All 260 people aboard the airplane and 5 people on the ground were killed.

The accident report[5] finds that the aircraft encountered two wake turbulence events and that the first officer responded to these with excessive rudder pedal inputs which resulted in the fracture of the vertical stabilizer from the fuselage. This accident was not caused by the wake turbulence itself, but by the pilot's reaction to it; however, it demonstrates the potential danger of wake vortices where pilot response is sub-optimal.

The Role Of The Air Traffic Controller

The role of the air traffic controller is crucial in reducing the number and seriousness of wake vortex turbulence. The ATCO has to walk the fine dividing line between optimizing traffic flow at his/her airport and maintaining a high level of safety.

ICAO regulations specify minimum separation standards for aircraft arriving at and departing from airports. In some cases, these standards have been increased by ANSPs in the light of actual experience.

Radar Separation

Leading Aircraft	Following Aircraft	Separation Distance
Heavy	Heavy	4nm
Heavy	Medium	5nm
Heavy	Light	6nm
Medium	Light	5nm

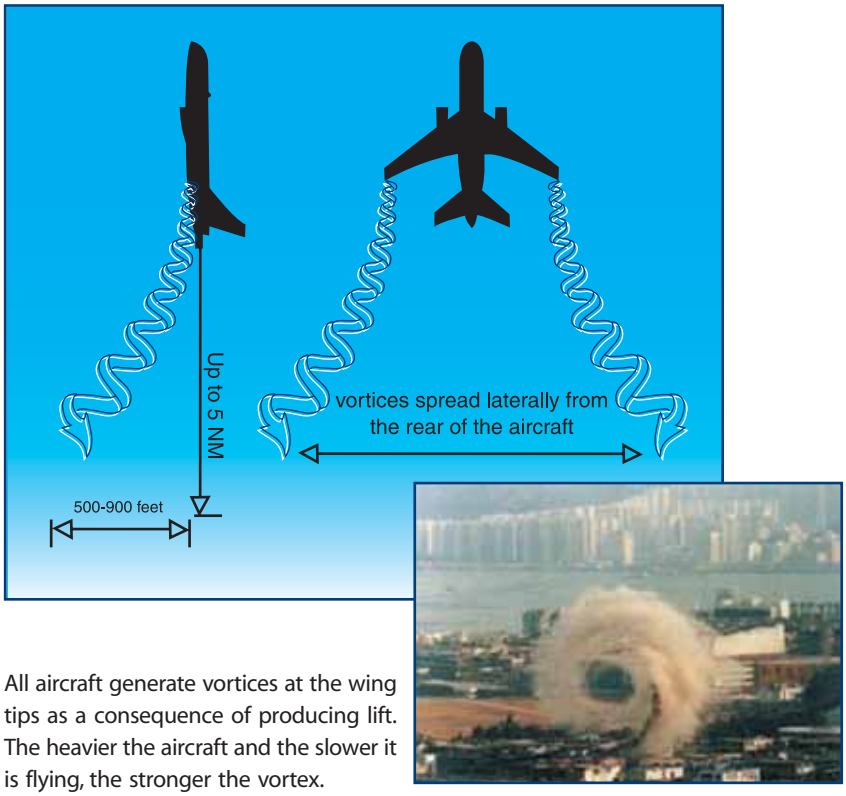
Non-radar Separation

Leading Aircraft	Following Aircraft	Separation Time Arriving	Separation Time Departing
Heavy	Medium	2 minutes	2 minutes*
Heavy	Light	3 minutes	2 minutes*
Medium	Light	3 minutes	2 minutes*

* 3 minutes if taking off from an intermediate position

[4] IFALPA - International Federation of Air Line pilots' Associations
[5] See http: //www.ntsb.gov/publictn/2004/AAR0404.pdf

In practice, these standards are a crude tool, for the circumstances which may give rise to wake turbulence are extremely complex. The following paragraphs, which explain some of these circumstances, are intended to help the ATCO apply the minimum separation standards intelligently.



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 65metres trails a vortex from both wingtips each with a diameter of around 65 metres.

Some aircraft, notably the Boeing 757, have particularly strong wake turbulence characteristics which can be experienced at much greater distances than would be expected, given the aircraft's weight.

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. Some pilots have reported encountering wake turbulence as much as 20 miles behind and 1000ft below a preceding aircraft.

Generally, the lighter the aircraft, the greater the degree of upset if a wake vortex is encountered. 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.

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.

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.

A significant proportion of the wake vortex incidents occur below 200 feet i.e. just before landing where there may not be room to recover. An accident in the UK badly damaged a light aircraft, which it appears got too close behind a landing turboprop. 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 2kt. 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.

Close to the ground where their effect is most hazardous, vortices generally persist for about 80 seconds. 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. At airfields where intersecting runways are both in use, the location of the vortex may be difficult to predict.

Some Recent Wake Vortex Turbulence Incidents

The following incidents occurred recently at various airports throughout Europe. Some of the reports are very brief, but they serve to indicate the type of problem that may be experienced.

Turbulence may be experienced even when separation from the preceding aircraft is greater than the minimum standards specified.