Section 3. Wake Turbulence

7−3−1. General

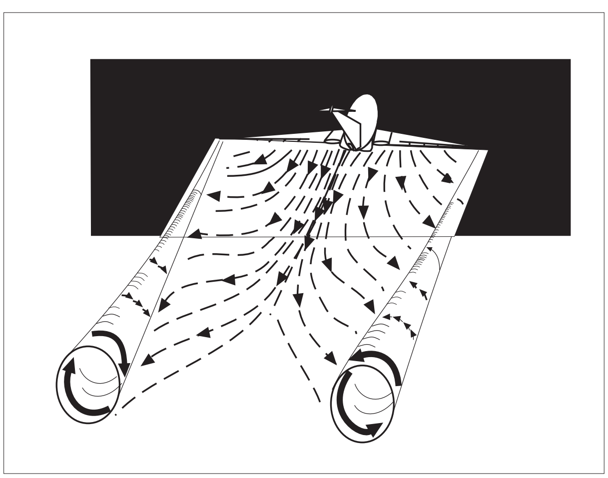
a. Every aircraft generates wake turbulence while in flight. Wake turbulence is a function of an aircraft producing lift, resulting in the formation of two counter−rotating vortices trailing behind the aircraft.

b. Wake turbulence from the generating aircraft can affect encountering aircraft due to the strength, duration, and direction of the vortices. Wake turbulence can impose rolling moments exceeding the roll−control authority of encountering aircraft, causing possible injury to occupants and damage to aircraft. Pilots should always be aware of the possibility of a wake turbulence encounter when flying through the wake of another aircraft, and adjust the flight path accordingly.

7−3−2. Vortex Generation

a. The creation of a pressure differential over the wing surface generates lift. The lowest pressure occurs over the upper wing surface and the highest pressure under the wing. This pressure differential triggers the roll up of the airflow at the rear of the wing resulting in swirling air masses trailing downstream of the wing tips. After the roll up is completed, the wake consists of two counter−rotating cylindrical vortices. (See FIG 7−3−1.) The wake vortex is formed with most of the energy concentrated within a few feet of the vortex core.

FIG 7−3−1
Wake Vortex Generation



b. More aircraft are being manufactured or retrofitted with winglets. There are several types of winglets, but their primary function is to increase fuel efficiency by improving the lift−to−drag ratio. Studies have shown that winglets have a negligible effect on wake turbulence generation, particularly with the slower speeds involved during departures and arrivals.

7−3−3. Vortex Strength

a. Weight, speed, wingspan, and shape of the generating aircraft's wing all govern the strength of the vortex. The vortex characteristics of any given aircraft can also be changed by extension of flaps or other wing configuring devices. However, the vortex strength from an aircraft increases proportionately to an increase in operating weight or a decrease in aircraft speed. Since the turbulence from a "dirty" aircraft configuration hastens wake decay, the greatest vortex strength occurs when the generating aircraft is HEAVY, CLEAN, and SLOW.

b. Induced Roll

1. In rare instances, a wake encounter could cause catastrophic inflight structural damage to an aircraft. However, the usual hazard is associated with induced rolling moments that can exceed the roll−control authority of the encountering aircraft. During inflight testing, aircraft intentionally flew directly up trailing vortex cores of larger aircraft. These tests demonstrated that the ability of aircraft to counteract the roll imposed by wake vortex depends primarily on the wingspan and counter−control responsiveness of the encountering aircraft. These tests also demonstrated the difficulty of an aircraft to remain within a wake vortex. The natural tendency is for the circulation to eject aircraft from the vortex.

2. Counter control is usually effective and induced roll minimal in cases where the wingspan and ailerons of the encountering aircraft extend beyond the rotational flow field of the vortex. It is more difficult for aircraft with short wingspan (relative to the generating aircraft) to counter the imposed roll induced by vortex flow. Pilots of short span aircraft, even of the high performance type, must be especially alert to vortex encounters.
(See FIG 7−3−2.)