# Wake Safety System to Increase Airport Capacity

## Wake Vortex Avoidance Systems Can Increase Capacity, Reduce Delays and Generate Savings

**It does not happen frequently, but the event can be a horrifying one for those involved. An airplane approaching touch down or just after lift-off encounters the wake vortex of a heavier airplane that preceded it and is rolled violently with little or no room to recover before crashing to the ground.**

A NASA photo showing a wake vortex illuminated by a smoke-generating flare.

### An Invisible Hazard

Wake vortices usually can not be seen by the naked eye, even though they are often described as horizontal tornadoes. Despite that, pilots rarely encounter the wake of a preceding aircraft. This is due in part to the standard wake vortex separation guidelines which adapt the space between landing and departing airplanes to allow the vortices time to dissipate before the passage of a lighter aircraft. Minimum radar spacing between airplanes in the terminal area is normally 3 miles. At some busy airports this is permitted to decrease to 2.5 miles on approach in order to accommodate the large demand. However, when an air traffic controller applies the wake vortex separation standards, the minimum spacing increases to 4, 5, 6 or even 8 miles depending on the relative weights of the two aircraft in each pair being controlled.

The international wake vortex separation standards have enjoyed an enviable safety record during the three and a half decades they have been in use. However, very often wake vortices do not dissipate in the time it takes to fly the 4–8 miles in-trail separation. Why, then, are wake encounters such rare events? The answer is simple, and easily explained by any experienced pilot. Wake vortex pairs behave in a predictable way, drifting with the ambient crosswind and descending under the influence of their own mutually-induced vertical wind. The wake of a leading aircraft quickly drifts out of the way of one following the same basic flight path.

Inside Flight Safety Technologies' data Integration trailer at Denver International Airport.

### Capacity Problems

The extra spacing imposed by air traffic controllers to avoid wake vortex encounters comes with a price: lost airport capacity. The world's airlines fly more airplanes today than ever before, and the prospect for continued growth is strong. As a result, a capacity problem looms large. As airports approach their maximum capacity, the increased delays due to the wake vortex spacing will grow expo-

nentially. Moreover, new super-heavy aircraft such as the Airbus A380 and, at the other end of the spectrum, thousands of very light jets, will soon enter the air fleets of the world, potentially contributing additionally to wake vortex related delays.

The air traffic service providers, of course, realize that current procedures rob capacity from those airports that can afford it the least. Research organizations in the US and Europe have studied this problem for decades in an attempt to find a solution to this dilemma. Proposed solutions have ranged from trying to reduce the strength of the vortex at the source, to breaking it up after formation, to just avoiding it wherever it is. While much is known about how wake vortices are generated and how they behave from generation to dissipation, there is still no system in place anywhere in the world that will provide ATC relief from the existing standards.

Because wake vortices can be so dangerous, the separation standards cannot simply be reduced to achieve a capacity benefit without very strong evidence that the reduction will not compromise safety. Many experts believe that such a solution exists because the vortices do in fact normally move out of the way of airplanes operating along the same nominal flight path. As long as there is no way to guarantee this behaviour, however, the existing spacing standard must be applied. The trick is to be able to predict and confirm that the normal behaviour has taken place and in fact that the trajectory of each vulnerable airplane is vortex free.

### The Aircraft Wake Safety Management (AWSM) System

Flight Safety Technologies (a small US firm, publicly traded on the American Stock Exchange under the symbol FLT) is developing a system called the Aircraft Wake Safety Management (AWSM) system. AWSM is comprised of precision weather and aircraft surveillance sensors, advanced prediction algorithms and wake vortex sensors all integrated to support a decision process which provides Air Traffic Control and pilots with a very simple information stream: either apply the minimum radar spacing between all aircraft or apply the standard wake vortex spacing. Also, to allow ATC to set up a stable traffic flow, local weather data will be used to estimate the amount of time before the recommendation is likely to change. NASA-sponsored studies have shown that a system like AWSM – when installed at a network of major airports – can generate hundreds of millions of dollars annually in cost savings due to reduced delays. Since those studies have not included the impact of the increasing mix of super-heavies and very lights, it's possible that the economic impact of such a system could surpass a billion dollars annually.

Bill Cotton, former Chief Technical Pilot for United Airlines and current Flight Safety Technologies President, describes the philosophy behind the system development. "No wake vortex avoidance system should rely solely on algorithms and software to predict wake vortex behaviour; it is critical that direct, real-time measurements of wake vortex positions at flight critical points are used to continuously validate the predictions and to provide a safety-net for the rare event that an incorrect prediction may lead to an encounter." Cotton also noted that the International Federation of Airline Pilots Associations (IFALPA) issued a Policy Statement in 1998 stating that reduction in the wake vortex spacing must be supplemented with a real-time monitoring system.

The AWSM system incorporates two types of real-time monitoring sensors: an opto-acoustic sensor called Socrates and a laser-velocimeter known as Lidar. Socrates uses lasers to measure and track the sound generated by the vortices, while Lidar directly measures the velocity field by shining a laser in the sky and recording the motion of particles that backscatter the light. The two sensors are complementary and will be used to monitor the wake in locations best suited to their respective strengths.

NASA and the US Department of Transportation's Volpe National Transportation Systems Center have participated in the development of AWSM. A functional emulation of the system will be demonstrated in the spring of 2007 at the Denver International Airport and will be ready for initial beta-site development later in 2007. Interest has been expressed by several airports in testing the system, including domestic US airports in Memphis (MEM), Las Vegas (LAS), Anchorage (ANC), and Honolulu (HNL). Internationally, Dubai Aerospace Enterprises has requested a benefits analysis for the Dubai International airport (DXB), and officials of Emirates Airlines have also expressed interest. A single beta-test site is all that is needed to complete the testing and demonstrate both the safety and capacity enhancements that the system is capable of delivering. The company hopes to raise the funds necessary to implement a beta-test site in 2007, so that the system can be ready for commissioning as early as 2008.

### The Need Is Urgent

In the mean time, the problem of airport capacity is only going to get worse at an increasing rate until the wake issue is adequately addressed. The increasing demand for air transportation coupled with the very large and small new aircraft being added to the fleet will take us toward "grid lock" faster than the government can cope by adding new runways or airports. While all of the recent attention to the capacity problem has been directed at flow control measures to constrain the burgeoning demand, it is time to increase the real capacity of our airports in terms of runway throughput. Only a comprehensive wake vortex avoidance system like AWSM can do this. Everything else runs up against the additional spacing constraint. Whether the lead is taken in the US or the European community will play out within the next very few years. In any case, air transportation services throughout the world truly hang in the balance.

*Contact:*
*Neal E. Fine, PhD*
*Flight Safety Technologies, Inc, North Kingstown/RI, USA*
*Tel.: +1 401 667 7254*
*Fax: +1 401 667 7258*
*nfine@flysafetech.com*
*www.flysafetech.com*