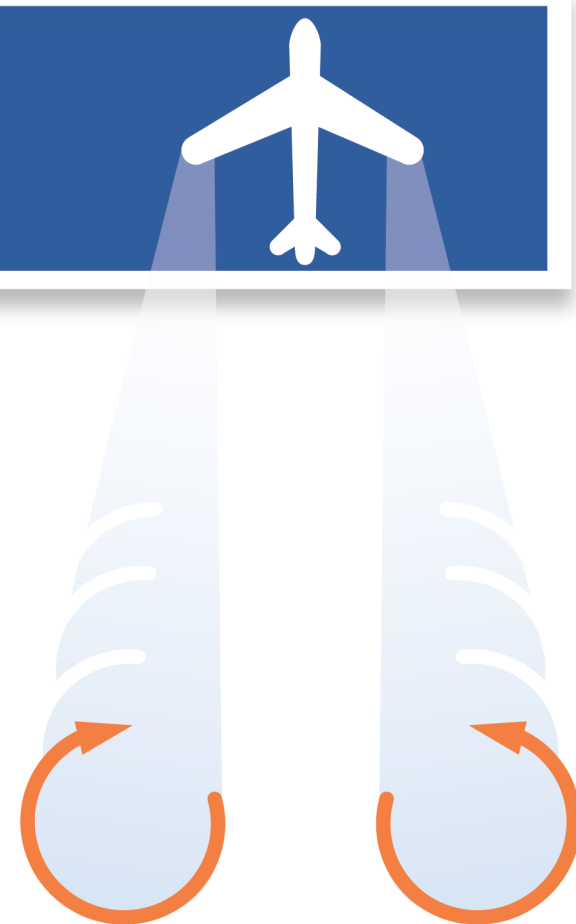


# Wake Turbulence Separation Standards for Aircraft



## Increasing Capacity and Making Air Travel Safer, Greener

### A key component of the Next Generation Air Transportation System

As airplanes move through the air, counter-rotating horizontal tornadoes are generated off the wings. This phenomenon, known as **wake turbulence**, creates a potentially dangerous situation for trailing aircraft. The **Federal Aviation Administration (FAA)** counts on experts at **Volpe, The National Transportation Systems Center**, to better understand the behavior of wake turbulence and to recommend critical adjustments to aircraft separation standards.



Volpe collects data at or near airports, often pioneering methods and equipment used to conduct the observations.



Volpe analyzes the data, systems, and procedures to inform FAA policies and regulations.



Volpe supports efforts to successfully implement new wake turbulence procedures around the globe.

## Success in Memphis: Transforming the Nation's Air Traffic Control System

- Aircraft at Memphis International Airport, home of the FedEx World Hub, can now **safely depart** — one behind another — slightly **closer than before**.
- In November 2012, controllers at the Memphis Tower and Terminal Radar Approach Control Facilities (TRACON) became the first to apply the new aircraft spacing criteria, known as **RECAT**, to **manage separation between aircraft** on final approach and during departure operations.
- Old standards separated planes based solely on weight. With RECAT, planes are **now categorized by design, approach speeds, and type of wing**, in addition to **weight**.
- RECAT is based on years of **joint R&D by FAA, Volpe, European Organisation for the Safety of Air Navigation (EUROCONTROL)**, and industry experts in wake turbulence and safety and risk analysis.

In Memphis, airport capacity has **increased 19%**.

Most FedEx aircraft can now be separated by **2.5 to 3.5 nautical miles (NM)** instead of the previously required **4 NM**.

**14 extra planes per hour**

### One Hour of Air Traffic in Memphis



Across the nation, other airports may see an average capacity increase of **7 – 10%** depending on the mix of aircraft.

**Louisville International Airport** became the second airport to use the RECAT standards. As a result, UPS and others now benefit from the implementation of new wake RECAT.

Discussions are underway with **several other U.S. airports** about implementing RECAT.

The new separation standards in Memphis are saving FedEx

**\$1.8 million a month in fuel costs.**

Plus, less time waiting on the tarmac results in a reduction in gas emissions.

## A New Air Traffic Management Tool to Reduce Delay, Improve Safety

The new tool, called Wake Turbulence Mitigation for Departures (WTMD), is based on Volpe's extensive wind and wake database.

The tool calculates more accurate separation time based on meteorology and aircraft category.

For the first time, **weather** is factored into aircraft departure timing.

### Before: 4 planes/12 mile queue

Each aircraft might have had to wait up to 3 minutes after the previous aircraft had departed.

Before WTMD, an entire runway could not be used.

Wind Direction

### After: 4 planes/9 mile queue

We now know that under certain wind conditions, some aircraft can shorten the standard wait time between departures.

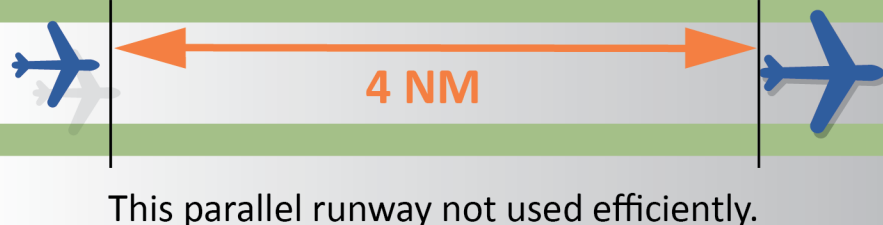
In **San Francisco and Houston**, jets are now allowed to **safely** take off from these busy airports slightly closer together due to WTMD.

Wind Direction

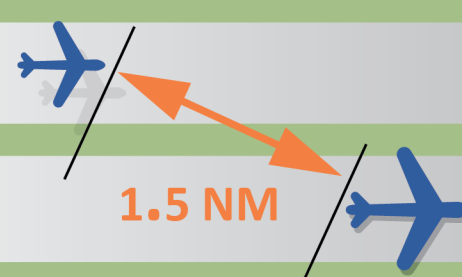
## Closely Spaced Runways Can Be Used More Frequently

- Research to improve understanding of wake turbulence is leading to **greater capacity** and **improved safety** at airports with closely spaced parallel runways — less than 2,500 feet apart.
- The FAA is moving to change the operational procedures at 8 airports to allow for **more departures** and **fewer delays**, under specific conditions.

### Before: Presumed size of wake vortex closed second runway



### After: Arrival queue can be split between two parallel runways



## Advancements in Sensor Technology



1969



2003

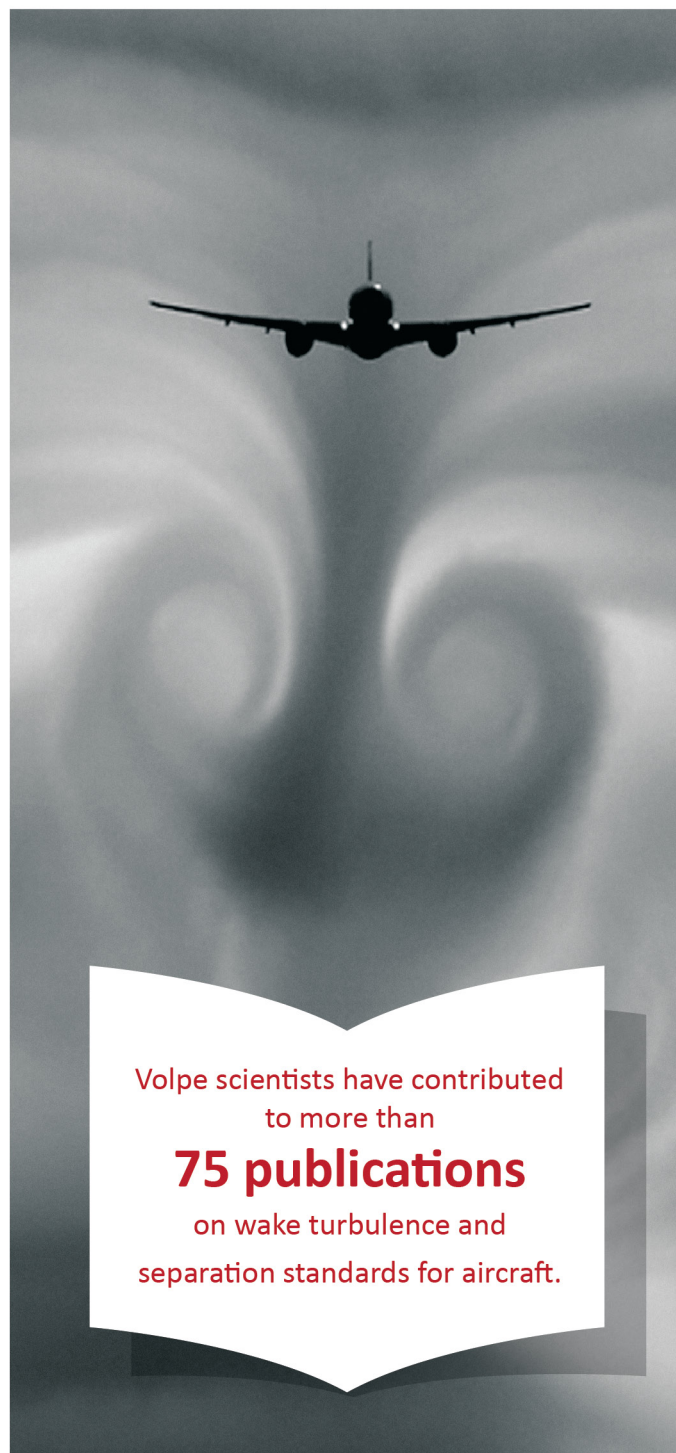
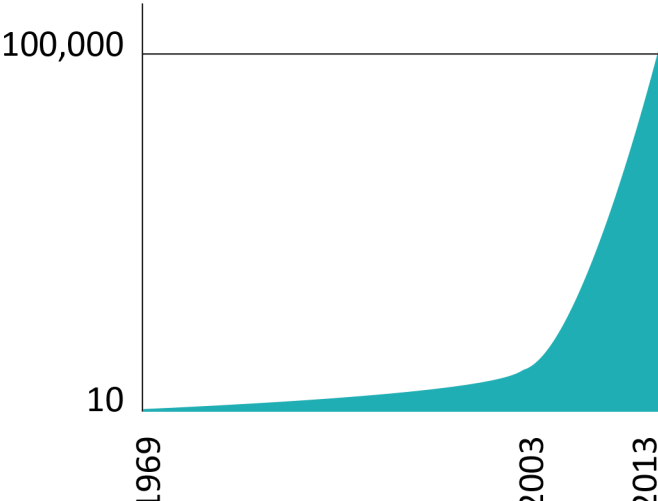
Volpe is the **only organization in the U.S.** that evaluates and deploys wake measurement sites and then collects, processes, and analyzes the wake sensor data.

- 1969** Smoke Tower Tests
  - Manned
  - 10 measurements per year**
  - Manual data collection
  - Dedicated flight tests

- 2003** Introduction of Light Detection and Ranging (LiDAR) Technology
  - Remote sensing
  - Thousands of measurements per year**
  - Automated data collection
  - High-quality data

- 2013** **100,000 measurements per year**

### Wake Measurements per Year



Volpe scientists have contributed to more than **75 publications** on wake turbulence and separation standards for aircraft.