Federal Aviation Administration Wake Turbulence Program - Recent Highlights

Jeffery Tittsworth (FAA)

Steven Lang* (Volpe)

Edward Johnson (FAA)

Steve Barnes (FAA – Retired)

WakeNet-Europe Workshop 2013

15-16, May 2013

STAC

Bonneuil-sur-Marne, France

*Presenter

Objectives of the Brief

- **Provides Some Historical Perspectives**
  - Where We (the Wake Community) Had Been
  - How Did We Get to Where We Are
- **Highlights Recent Progress in FAA Wake Turbulence Program**
  - FAA Specific Efforts
  - Collaboration with International Partners
- **Moving Forward**

Historical Perspective

What's Different Now

- **Historical Background: No Significant Operational Changes Benefiting the National Air Space (NAS) Prior to 2000**
  - Close to 30 Years R&D with most of that being Research
  - Earlier Efforts to Change Standard Ineffectively Coordinated Between Researchers and Users

Historical Perspective

What's Different Now

- **Program Leadership Redirection**
  - Focusing on Operationally Feasible Solutions Using More than Well Established Wake Science to Date
  - Airport Specific Solutions Instead of Trying to Provide "The Grand Unified Solution" (One size does not fit all)
  - Insight that Wake Turbulence Solutions to the NAS Does Not Revolve Solely on Wakes from Heavy Aircraft
  - Phased Approach – Near, Mid to Far Term Goals
    - Small, Stepwise Achievements Defined by the FAA.
    - Focused R&D for Each Specific Defined Goal.
    - Result Has Been a Steady Evolution of Solutions which Increased in Complexity and Applicability as They Were Developed.

Historical Perspective

What's Different Now

- **Advancements of Sensor and Information Technologies**
  - Smoke Visualization in the 1970s to Long Range and Unattended Remote Sensors in the 2000s (Particularly Pulsed LIDAR – Laser Radar)
  - Statistically Large Amount of Data Collection Now Routine, Including
    - Seasonal and Diurnal Effects
    - Aircraft ID Details Down to Make Model and Series
  - Entire Safety Critical Region Can be Addressed via Direct Measurements
    - Arrival: From Stabilized Approach Point Down to Runway Threshold
    - Departure: From Rotation Point to Point of Divergence

Historical Perspective

Routine/Production Wake Sensing

Tower Visualization and Measurements

Aircraft Smoke Visualization

CW Lidar

Windline

Acoustic Radar – Bi-Static

Acoustic Radar – Mono-Static

Pulsed Lidar

Historical Perspective

What's Different Now

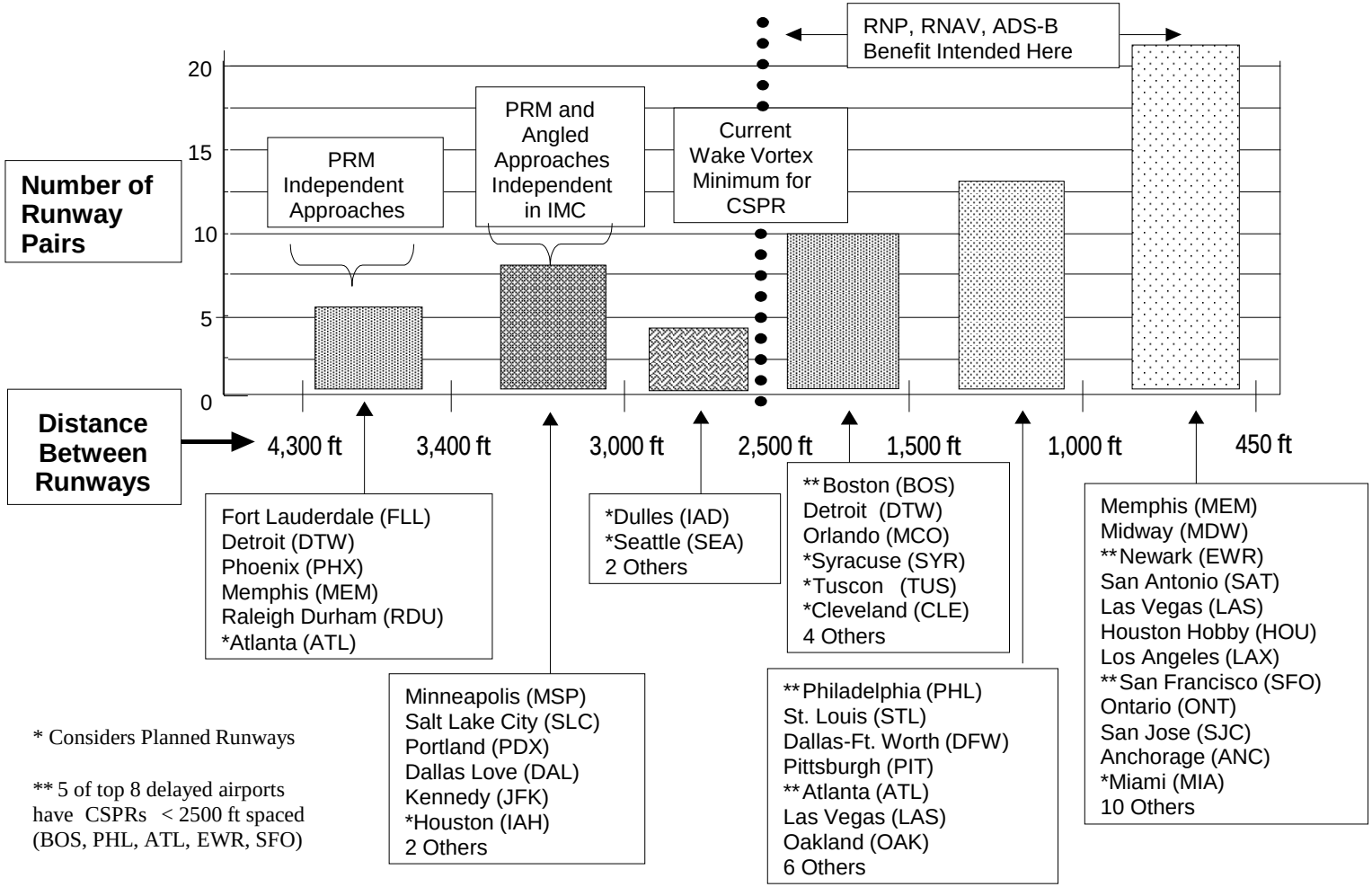
- **Industry/Stakeholder Involvement**
  - Safety Management System (SMS) Process – Provides a Rational, Documentable and Repeatable Safety Assessment
  - Periodic Meetings Dedicated to Solicitation of End-User/Stakeholder Feedback (Such as WakeNet Europe and WakeNet USA)

Highlight Developments in Two Specific Areas

- **Closely-Spaced Parallel Runway Wake Separation**
  - Arrival
  - Departure
- **Single-Runway / In-Trail Wake Separation**
  - Arrival
  - Departure

Closely Spaced Parallel Runways (CSPR)

Runway Spacing Less Than 2500 Feet/760 Meter



* Considers Planned Runways

** 5 of top 8 delayed airports have CSPRs < 2500 ft spaced (BOS, PHL, ATL, EWR, SFO)

Closely Spaced Parallel Runways (CSPR)

Runway Spacing Less Than 2500 Feet/760 Meter

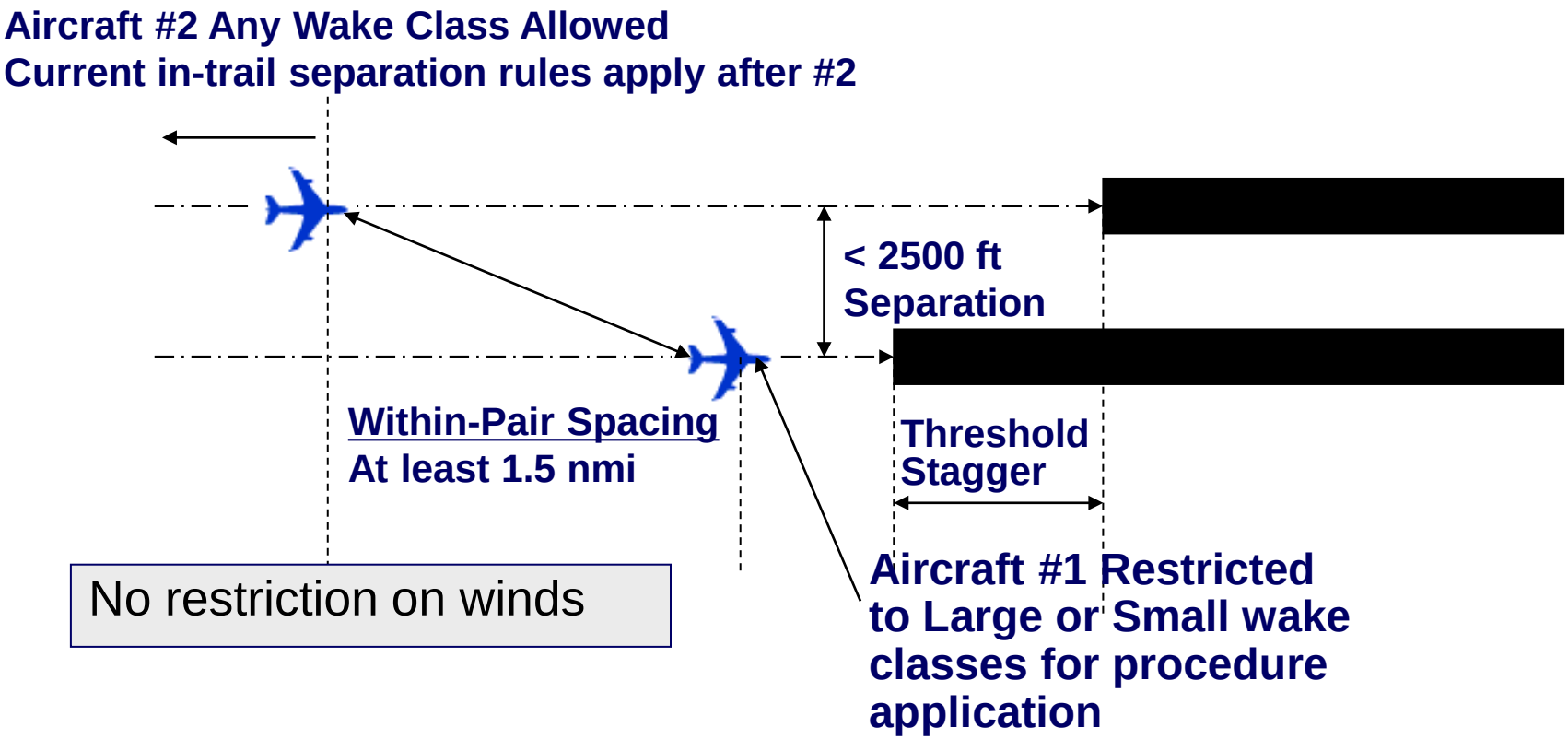
- The “2500ft/760m Wake Turbulence Rule” Effectively Shuts Down One Runway of the CSPR Pair Under IMC/Marginal VMC
- 2500ft/760m Rule Was Implemented to Protect a Smaller Aircraft from Wakes of a Heavier Aircraft
- In Practice, It also Protected a Heavier Aircraft from the Wakes of a Smaller Aircraft (unneeded)
- 2500ft/760m Rule Clearly Can be changed for Some Conditions

Cessna 525A
Citation CJ2
Wingspan = 46’ 9”

Boeing 747-400
Wingspan = 211’ 5”

Staggered CSPR Arrivals (FAA JO 7110.308)

Instrument Procedure for 1.5-nmi Dependent Spacing



- ❑ **Authorized for 8 major airports**
- ❑ **Under investigation: 2 additional major airports**

Staggered CSPR Arrivals (FAA JO 7110.308)

Instrument Procedure for 1.5-nmi Dependent Spacing

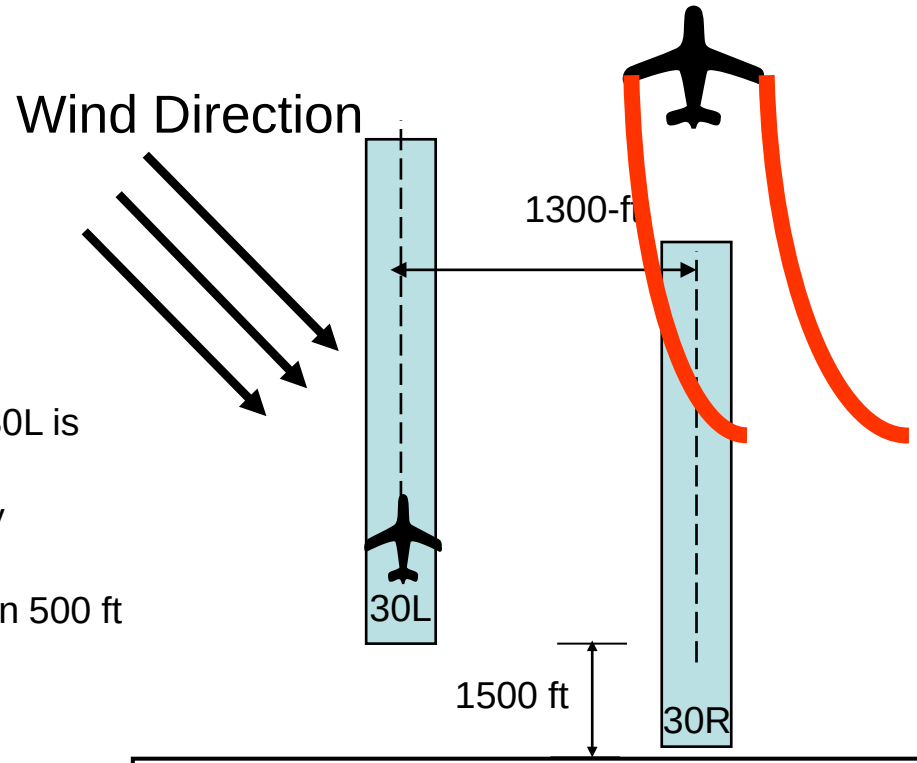
- 7110.308 Allows Capacity Recovery During IMC/Marginal VMC
  - Airline Scheduling Based on VMC
- CSPR Operation Safety is Even More Enhanced
  - Long Term Wake Data Collection Revealed Enhanced Safety Margin Under 7110.308 Scenario on the Adjacent CSPR
- The Development of 7110.308 Benefited from the DFS Reduced Diagonal Separation Minima (RDSM) and elements of HALS/DTOP Efforts at EDDF
  - Framework of a Relative Safety Assessment
  - Demonstration the Importance of Runway Stagger
  - Importance of the Aircraft Dispersion Characteristics
- The Development of 7110.308 Benefited Also from NASA's Airspace Systems Program / Efficient Aircraft Spacing Project
  - Extended Coverage of an Experimental Multi-Lateration Flight Tracking System

Wake Turbulence Mitigation Departure (WTMD)

Wind Based CSPR Departure

Goal: Up-wind runway departures not restricted by down-wind runway departures

Need: A reliable wind forecast algorithm (WFA) that can predict the WTMD windows



Before WTMD:

- Wind not considered
- For STL geometry shown, Large departing 30L is considered an intersection takeoff
- Aircraft on 30L has to wait 3 min after Heavy departs 30R
- 2 min wait required when stagger is less than 500 ft

- **Operational Demo at SFO, IAH & MEM**
- **Potential Implementation at 10 Airports After Operational Demo**

Weather Minima

- **Sufficient to visually observe divergent paths after departure**
- **Approximate 1000' ceiling and 3 mile visibility**

Wake Turbulence Mitigation Departure (WTMD)

Wind Based CSPR Departure

AVIATION WEEK INTELLIGENCE NETWORK
MARKET BRIEFING
May 13, 2013 • PAGE 3

Three Domestic Airports To ~~Test~~ FAA's Reduced Separation Tool

AIR TRAFFIC MANAGEMENT Controllers at the San Francisco, Houston and Memphis international airports will have a new tool to reduce delays starting May 15, May 20 and August 5, respectively, as part of a one-year FAA pilot program.

Called wake turbulence mitigation for departures (WTMD), the program, under certain wind conditions, allows aircraft departing from closely spaced parallel runways (those less than 2,500 ft. apart laterally) to avoid the standard 2-3 min. wait time between departures.

WTMD is one of several wake turbulence-related initiatives the FAA has been studying with industry and academia since 2006. In November, the agency approved controllers at Memphis International Airport to begin using a recategorization (Recat) of aircraft by weight in terms of required separation criteria from other aircraft.

http://www.aviationweek.com/awin/ArticlesStory.aspx?keyWord=WTMD&id=/article-xml/avd_05_13_2013_p03-01-577876.xml

Wake Turbulence Mitigation Departure (WTMD)

Wind Based CSPR Departure

- Capitalized on International and Inter-Agency Collaboration
  - WFA is a modification to one developed for the Wake Vortex Warning System (WVWS) for *DFS Deutsche Flugsicherung GmbH* by DLR
  - Data collected in a joint effort with EUROCONTROL at FRA/EDDF in their pursuit of a wind dependent single runway wake mitigation solution called the Crosswind Reduced Separations for Departure (CREDOS) project.
  - Although an FAA NextGen deliverable, NASA partnered with the FAA, with the NASA role being the development and assessment of a non-operational prototype.

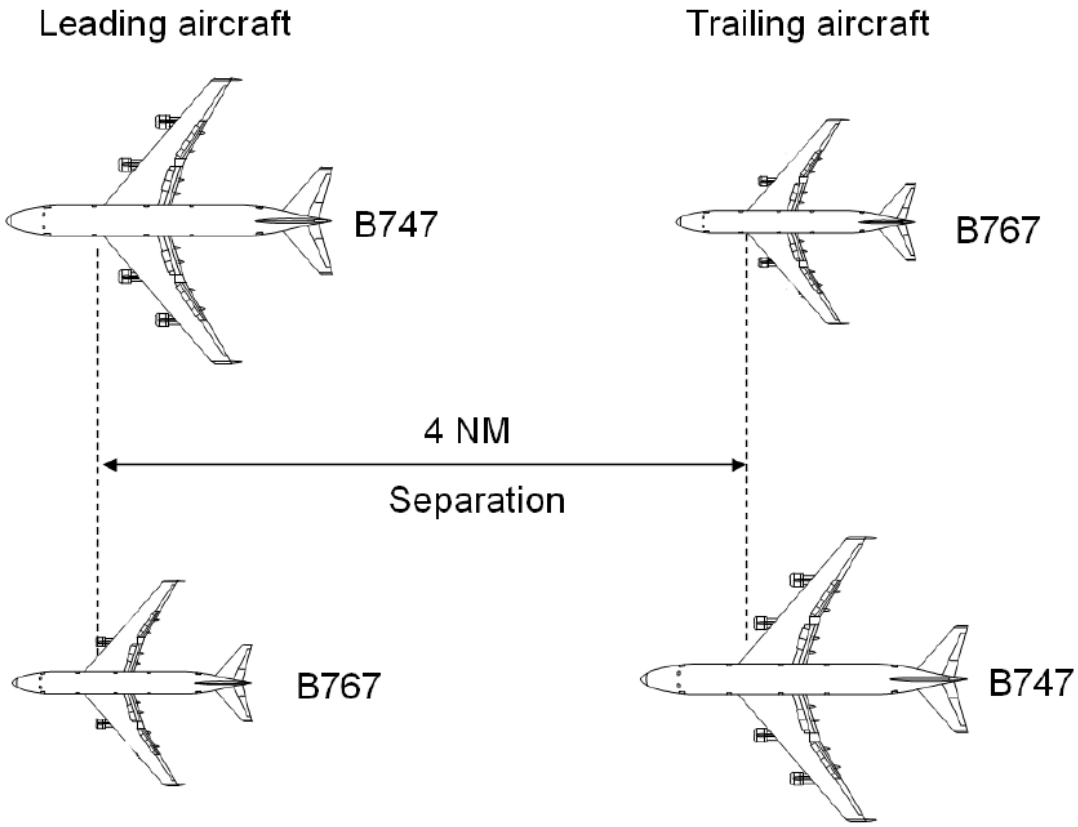
Wake Turbulence Mitigation Departure (WTMD)

Wind Based CSPR Departure

- The first automation driven wake separation change that allows dynamic separation based on meteorology and aircraft category
- Improves capacity under visual meteorological conditions
- Safety of the aircraft operating on the wake free runway is enhanced even further than pre-WTMD's CSPR operation
- Scientifically, it illustrates that short term wind nowcasting has become far more matured than previously realized

Wake Turbulence Recategoriztion – RECAT I

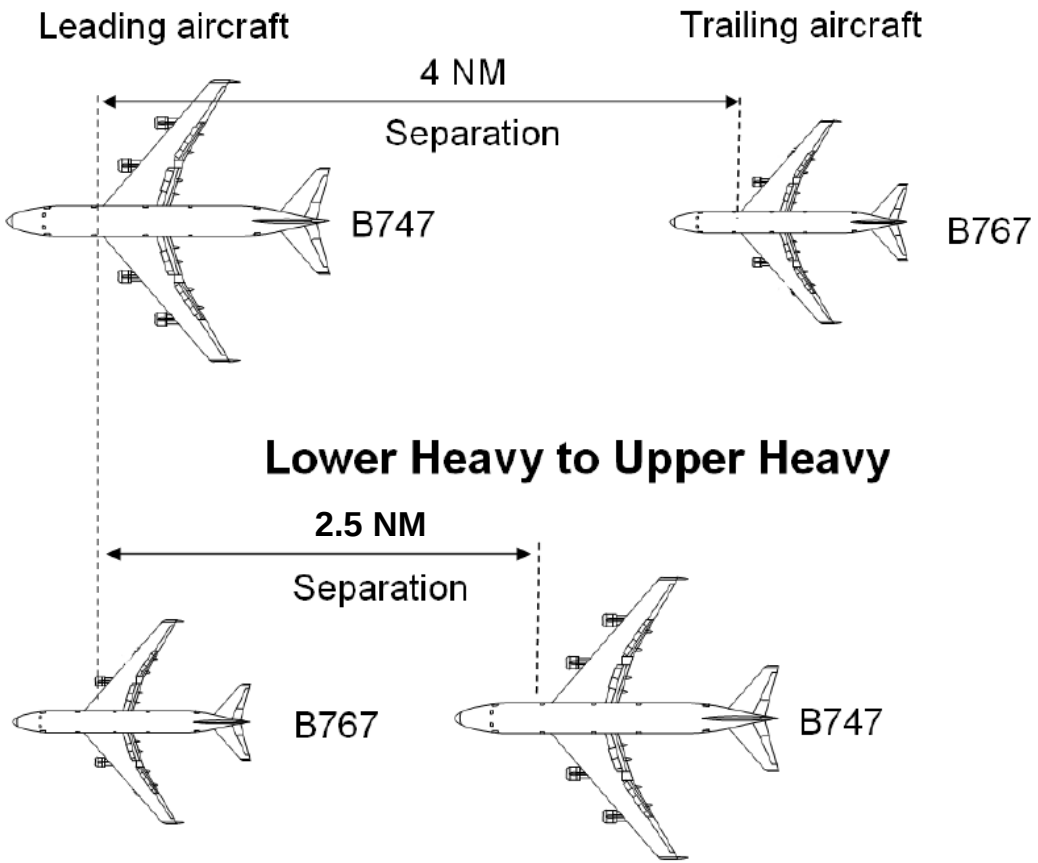
Examples on Why Some Wake Separations Can be Safely Reduced



"Status Quo"

Wake Turbulence Recategoriztion – RECAT I

Examples on Why Some Wake Separations Can be Safely Reduced



Spacing Can be Safely Reduced For Bottom Pair to Less than 4 NM

Wake Turbulence Recategoriztion – RECAT I

- RECAT is a Three-Phase Approach:
- RECAT I: Collaborative Effort Between FAA and EUROCONTROL
  - Wake Data Sharing (LHR[1], CDG[2], FRA[3], SFO[4], JFK[5], MEM[6], DFW[7])
  - Exchange of Wake Data Analysis Expertise
  - Exchange of ATM / Operational Expertise
  - Exchange of Safety Assessment Expertise
- RECAT I: Within a Static Wake Separation Minima Framework, Change from a MTOW Based Standard to a Wake Based Standard
  - Split the Heavy Category into Super, Upper and Lower Heavies
  - Placed Additional Safety Buffer to Further Protect the FAA Lower End Small or ICAO Light Aircraft Followers

1 TBS ; 2 WIDAO ; 3 CREDOS ; 4 SOIA ; 5 FAA-NASA R&D; 6 NASA AVOSS ; 7 NASA AVOSS

Wake Turbulence Recategoriztion – RECAT I

- RECAT is a Three-Phase Approach:
  - RECAT I: Global Harmonization for a Static Six Category Based System
  - RECAT II: Global Harmonization for a Set of Static Pair-Wise Wake Separation Minima Standards
  - RECAT II: Individual ANSPs Can Then Optimize the Categories from the Static Pair-Wise Wake Separation Minima
  - RECAT III: Dynamic Pair-Wise Wake Separation Minima
    - Meteorology, Aircraft Parameters, Aircraft Trajectory/Navigation Based

Wake Turbulence Recategoriztion – RECAT I

Status and Ongoing Plan

- Memphis (MEM) Became the Key Site to Adopt RECAT Phase I Wake Separation Spacing Prior to NAS roll out (November 1, 2012 FAA JO 7110.608)
- MEM Lessons Learned (automation, training, more representative matrices to measure RECAT I impact, etc.) Will be Incorporated at Subsequent Airport Implementations
- Phase II Activities Ongoing
  - FAA and EUROCONTROL Jointly executing the R&D with other contributors and partners
  - Stakeholder Inputs/Contributions being solicited

Other Wake Program Activities / Deliverables

- **A380, B747-8 and B787**
  - Established the Appropriate ICAO Wake Spacing for These Aircraft with International Partners (EUROCONTROL, EASA, ICAO, Airframe Manufacturers)
- **B757 Harmonization**
  - Harmonized the Separation Spacing for All Three Variants of the B757 in the US
- **Jet Blast at JFK**
  - Not a Wake Turbulence Issue, But Demonstrated that Wake Turbulence Separation Applied at JFK for Intercepting Runway Geometry was Not Necessary
  - Improved Efficiency for Intercepting Runways

Closing Remarks

- **FAA Wake Turbulence R&D Has Come a Long Way Since 1970s (or Even 2001)**
  - FAA Wake Investment is Contributing to Positive Operational Impacts
  - Safely and Efficiently Enabling NextGen's Overall Goal to Reduce Delays, Enhance Operational Efficiency and Capacity Improvements
  - Reduced Emission, Although not a Wake Program Deliverable, Became a Bi-Product
  - Benefited Significantly from
    - International Collaboration
    - Inter-Agency Collaboration
    - Advances in Sensors and Information Technologies
    - SMS Process
    - Stakeholder Engagement

Moving Forward

- **Wake Turbulence solutions are not solely a US or EU concern, rather a Global Aviation concern**
- **For the Global Success / Impact**
  - **Manufacturers** have a role in providing aircraft performance data
  - **Researchers** have a role in developing proposed changes that are operationally achievable
  - **Airlines and other Operators** have a role in describing the importance of an operational change and acting as an advocate
  - **Regulators** have the role of assessing the safety of a proposed change
  - **ANSPs** have the role of implementation of the proposed change in an acceptably safe manner

Additional Information

Tittsworth, Lang, Johnson and Barnes, “Federal Aviation Administration Wake Turbulence Program - Recent Highlights,” presented at the 57th Air Traffic Control Association (ATCA) Annual Conference & Exposition, October 2012

Questions?