FAA Progress on Wake Avoidance Solutions for Closely Spaced Parallel Runways (CSPR)

WakeNet-Europe Workshop 2015
April 2015
Amsterdam, The National Aerospace Laboratory (NLR)

- Tittsworth (FAA Air Traffic Organization)
- Strande (FAA NextGen/CSPO Integration)
- Zinke (FAA Flight Standards Service)
- Lang (Volpe NTSC)
- Barnes (Engility Corporation)
- Lunsford (MITRE)
Outline

Background
- Why CSPR?
- Past CSPR Efforts
- Interface with Interagency and International R&D

Updates
- Present/Ongoing and Near term Future CSPR Efforts
- Interfacing with Other Aspects of Wake Turbulence Efforts
- Farther Term R&D
Closely Spaced Parallel Runways (CSPR)

- CSPR: Runway Spacing Less than 2500 Ft*
- Under Reduced Weather/Visibility Condition, CSPR Operations Stops and Traffic Resorts to Single Runway Operations
  - Details In Part Related to Wake Separation Responsibility
- Airlines Schedule Based on VFR Runway Availability
  - So Shutting Down One Runway Causes Delays
- Solution is to Develop Dependent Diagonal Separation Approaches under IFR that Addresses Wake
  - Recovery of Capacity Loss

*CSPR is sometimes defined as runway spacing Less than 4300 feet in other context. CSPR is defined here as being less than 2500 feet from wake turbulence perspective.
CSPR Operations and Wake Turbulence

Good VFR Condition – Independent Operations

IFR Operation Without CSPR Wake Mitigation

IFR Operation With CSPR Wake Mitigation

Smallest Common Distance
The “2500 Ft Wake Turbulence Rule” Effectively Shuts Down One Runway of the CSPR Pair Under MVMC

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 (Intuitively Not Needed)
2500 Ft Rule

Therefore, Opportunities Exist to Relax the CSPR 2500 Ft Wake Rule

Identifying These Opportunities and Making More Efficient Use of CSPR Runways is a FAA NextGen Goal

R&D Efforts Coordinated Across Multiple FAA Organizations

Historical Note: Early FAA CSPR Wake Mitigation Solution Development Influenced by the Studies and Relative Safety Arguments in FRA HALS/DTDOP
Why the US Investment In CSPR Solutions?

Number of Runway Pairs

Distance Between Runways (ft)

Independent Approaches

Independent Approaches with PRM

Dependent Staggered Approaches

Wake Mitigation Solutions for CSPRs

- Detroit (DTW)
- Fort Lauderdale (FLL)
- St. Louis (STL)
- Atlanta (ATL)
- Milwaukee (MKE)

- John F Kennedy (JFK)
- Philadelphia (PHL)
- Portland (PDX)
- Minneapolis (MSP)
- Salt Lake City (SLC)
- 6 others

- Seattle (SEA)
- Denver (DEN)
- St. Louis (STL)

- Boston (BOS)
- Orlando (MCO)
- Philadelphia (PHL)
- Seattle (SEA)
- Detroit (DTW)
- Long Beach (LGB)

- Houston (IAH)
- Atlanta (ATL)
- Las Vegas (LAS)
- Chicago (ORD)
- Dallas (DFW)
- Philadelphia (PHL)
- 9 others

- Los Angeles (LAX)
- San Francisco (SFO)
- Miami (MIA)
- Phoenix (PHX)
- Seattle (SEA)
- Memphis (MEM)
- Las Vegas (LAS)
- Newark (EWR)
- 10 others

Recent Δ
Aircraft #2 Any Wake Class Allowed
Current in-trail separation rules apply after #2

Within-Pair Spacing
At least 1.5 nmi

< 2500 ft Separation

Threshold Stagger

Aircraft #1 Restricted to Large or Small wake classes for procedure application

No restriction on winds
Staggered CSPR Arrivals - FAA 7110.308

- Taking Advantage of Runway Centerline Spacing
  - Lateral Mitigation from Wake Risk
- Taking Advantage of Threshold or Glide Slope Angle Differential
  - Vertical Mitigation from Wake Risk

Within-Pair Spacing
At least 1.5 nmi

< 2500 ft Separation

Threshold Stagger

No restriction on winds
FAA 7110.308 Status

- Eight Airports Approved to Conduct .308 Operations
- Operational Experience Obtained at Two Major Airports
  - SEA and SFO
- SFO is the Most Dominant User of .308 To Date
  - Routine Use Since Its Approval in October 2012
  - IMC Rate Increased from 30 to 33 (higher rate planned)
  - Very Positive Feedback from SFO Controllers
- BOS Implementation Ongoing
- Evolving into All Weather Condition Applications
  - Airports Often Forced to Run IFR Procedures Under VFR
  - Most Recent Interest Expressed by LAX
WTMA-P / 7110.308A

- Wake Turbulence Mitigation for Arrival – Procedural (WTMA-P)
- Expansion of the Original 7110.308 Concept
  - Allowing Heavy and B757 leaders, or Cat B and Cat C leaders at RECAT airports with the exception of the RECAT CAT A.
- Minimum Diagonal Separation Distance for the Aircraft Pair Depends on
  - Airport Specific Runway Centerline Spacing, Runway Stagger and Approach Procedures (ILS vs RNAV)
  - Leader and Trailer Aircraft Types
WTMA-P / 7110.308A Concept

Aircraft 4 = Any

1.5 nm**

Aircraft 3 = B757

<2500 ft

Aircraft 2 = Any

2.0 nm**

Aircraft 1 = B777

No restriction on winds

Separation behind Aircraft 1 or Aircraft 2 (whichever is greater): per FAA Order 7110.65, para 5-5-4g, or FAA Order 7110.659A, Appendix A, Table 5-5-2

**Notional diagonal separation
WTMA-P / 7110.308A Status

- The Safety Risk Management Document (SRMD) was approved December 2014
  - Assesses Risk for Hazards Related to the WTMA-P
  - Provides Analysis, Proposed Separation, and Implementation Options for PHL and DTW.
  - Allows Expansion of Analysis to More Sites in the Future, Similar to the Phased Implementation of 7110.308.
- Expected Approval of Updated 7110.308A Order is May 2015.
- ATL is the Current WTMA-P Airport Under Study
WTMD - FAA 7110.316

- WTMD = Wake Turbulence Mitigation for Departure
- Wind Based CSPR Solution
- First Automation Driven Wake Separation Change Based on Meteorology and Aircraft Wake Category
- Capitalized on Inter-Agency and International Collaborations
  - NASA Developed and Assessed a Non-Operational Prototype
  - Wind Forecast Algorithm Based on DFS Funded R&D
  - Departure Data Collection Jointly Conducted with
    - EUROCONTROL
    - DFS
Without / Before WTMD

- For SFO Geometry Shown, Large Departing 01L is Considered an Intersection Takeoff
- Aircraft on 01L Has to Wait 3 min After Heavy Departs 01R
- 2 min Wait Required When Stagger is Less Than 500 ft
- If Wind is Preventing Wake Transport from 01R Reaching 01L, It Is Not Considered in Operation
With WTMD

- A Wind Forecast Algorithm Determines the Availability of WTMD Operation
- Same Scenario Shown as Before, the Large Aircraft on 01L Can Departure Without Wake Constraint
- Removes the up to Three Minute Wait
- Provided the Necessary Weather Minima Exist
  - 1000 ft Ceiling and 3 SM Visibility, or
  - Sufficient to Visually Observe Divergence After Departure
WTMD / 7110.316 Status

- Approval for WTMD Operation for 10 Airports
- Three Airports Selected for Operational Demonstration
  - SFO, IAH and MEM
  - Operational Demonstration Phase Ended in December 2014
- SFO is the Most Dominant User of WTMD To Date
- WTMD being a System, Continuation of WTMD May Require Following FAA Acquisition Management Processes
- Operational Experience from SFO and IAH Identified Areas of Improvement in Wind Forecast Algorithm
SFO’s Wind Forecast Algorithm (WFA) Parameter Details Refined
- Assisted by SFO Operational Experience and Additional Lidar Wind Data
- Data Showed the Original Parameters Can be Safely Relaxed to Provide Additional WTMD Availability / Benefit
- Increases Availability from 14 to 27 Percent

Safety Risk Management Panel Was Convened in Feb 2015

SRMD Addendum for the SFO Change is Underway
WTMD / 7110.316 Status - Overall

- To Provide Additional Availability/Benefit for Wind Based CSPR Departure, Wake Turbulence Research Office is Examining Elements of Concepts Originated from FAA NextGen / CSPO (Closely Spaced Parallel Operations) Efforts.
- WTMD-PD (WTMD-Paired Departure) is One Such Concept
WTMD-PD

- Instead of Waiting for Wind Conditions to Keep the Wake Away, Depart the Trailing Aircraft Before Wake From the Lead Aircraft Has Time to Transport to the Trailing Aircraft Flight Path
- Takes Advantage of WTMD Algorithms and Infrastructure Already Established with Only Minor Modifications
- Has Potential to Significantly Increase Availability of CSPR Reduced Departure Separations
- Has Additional Human Factor Challenges
WTMD vs. WTMD-PD

Predict “wake free” periods

WTMD*

Favorable Crosswind Required

Wait

Predict “wake free” windows

Paired

Tolerate Some Adverse Crosswind

Safe Window
WTMD-PD

- Shorter Inter-Departure Time Translates to Higher Tolerance on Adverse Crosswind (And More Available WTMD-PD Operations)
- Larger Runway Spacing Translates to Higher Tolerance on Adverse Crosswind (And More Available WTMD-PD Operations)
WTMD-PD Status

- Currently in R&D Phase
  - Conop Development, Shortfall Analysis, and HITL Conducted
- SFO and IAH Adverse Wind Tolerance Specified (Runway 01s and 15s, Respectively)
- FAA Supporting Organizations Are Examining
  - WTMD-PD Availability
  - WFA False Green Statistics
  - Benefit Analysis (Availability vs Demand)
- An Iterative Process Ultimately Leading to Wake Risk Analysis Under WTMD-PD
  - Nominal Operations
  - Off Nominal Operations
Beyond WTMA-P (Back to Arrivals)

- WTMA-S Was Originally Envisioned as a Follow on to WTMA-P
  - “S” Stands for System
  - Arrival Analogue to WTMD
- Given Recent Proposed Changes to WTMD, Changes to WTMA-S Should Also be Considered
- Need to Define the Distance Needed for the CSPR Follower to Stay Ahead of the Wakes from Aircraft on Adjacent Runway
WTMA-S

Aircraft 1 = Heavy

Acceptable Wind Condition

Aircraft 1 is assigned to lower approach

Aircraft 3 = B757

1.5 nm**

<2500 ft

1.5 nm**

Aircraft 2 = Any

Aircraft 4 = Any

or

Separation behind Aircraft 1 or Aircraft 2 (whichever is greater): per FAA Order 7110.65, para 5-5-4g, or FAA Order 7110.659A, Appendix A, Table 5-5-2

**Notional diagonal separation
Federal Aviation Administration

Acceptable Wind Condition

WTMA-PA

Aircraft 1 = Heavy

1.5 nm**

Aircraft 3 = B757

<2500 ft

Aircraft 2 = Any

Targeted Window

Aircraft 1 is assigned to tower approach

or

Separation behind Aircraft 1 or Aircraft 2 (whichever is greater) per FAA Order 7110.65, para 5-5-4g, or FAA Order 7110.659A, Appendix A, Table 5-5-2

**Notional diagonal separation
WTMA-PA Status

- R&D Phase – R&D Areas:
  - Conops, ATC and Flight Crew Procedure Development, HITLs to be Conducted
  - Initial Operations Likely to Be Controller Focused
  - Wind Forecast Requirement is More Challenging
    - Larger Spatial Coverage than Departure
    - Longer Forecast Need than Departure
  - Source of Wind
    - Aircraft Based Wind is Being Evaluated
  - Performance Requirements of Wind Forecast
  - Additional Automation Tools or Modification of Existing Tools
  - Wake Risk Analysis
  - Benefit Analysis
Overall Interfacing with RECAT

- Some Approved CSPR Wake Solutions Were Developed Before RECAT I, and Thus with FAA 7110.65 Aircraft Wake Categories
- FAA Recently Completed the Additional Analysis Needed to Properly Map CSPR Solutions and Associated Categories to RECAT I Vernaculars (i.e., FAA 7110.308A)
- RECAT Phase II Effort Intends to Provide Wake Separation Minima Below the Current MRS of 2.5 NM, Future CSPR Wake Analysis Expected to Consider RECAT II Spacing as Part of the Framework
Summary

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Separation Standards for More Widely Spaced Parallel Runways

- Note that work is ongoing for several non-wake related separation minima for arrival to parallel runways
  - Dependent staggered separation minima for runways > 2500 ft are also relevant to CSPRs
  - Changes in the second case below will be brought to 7110.308

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<th>Current</th>
<th>Objective</th>
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<td>≥ 2500 ft</td>
<td>≤ 4300 ft</td>
</tr>
<tr>
<td>1.5 NM</td>
<td>2.0 NM</td>
</tr>
<tr>
<td>≥ 3600 ft</td>
<td>1.5 NM</td>
</tr>
<tr>
<td>≥ 3600 ft</td>
<td>1.0 NM</td>
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</tbody>
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Dependent Approaches for CSPRs