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

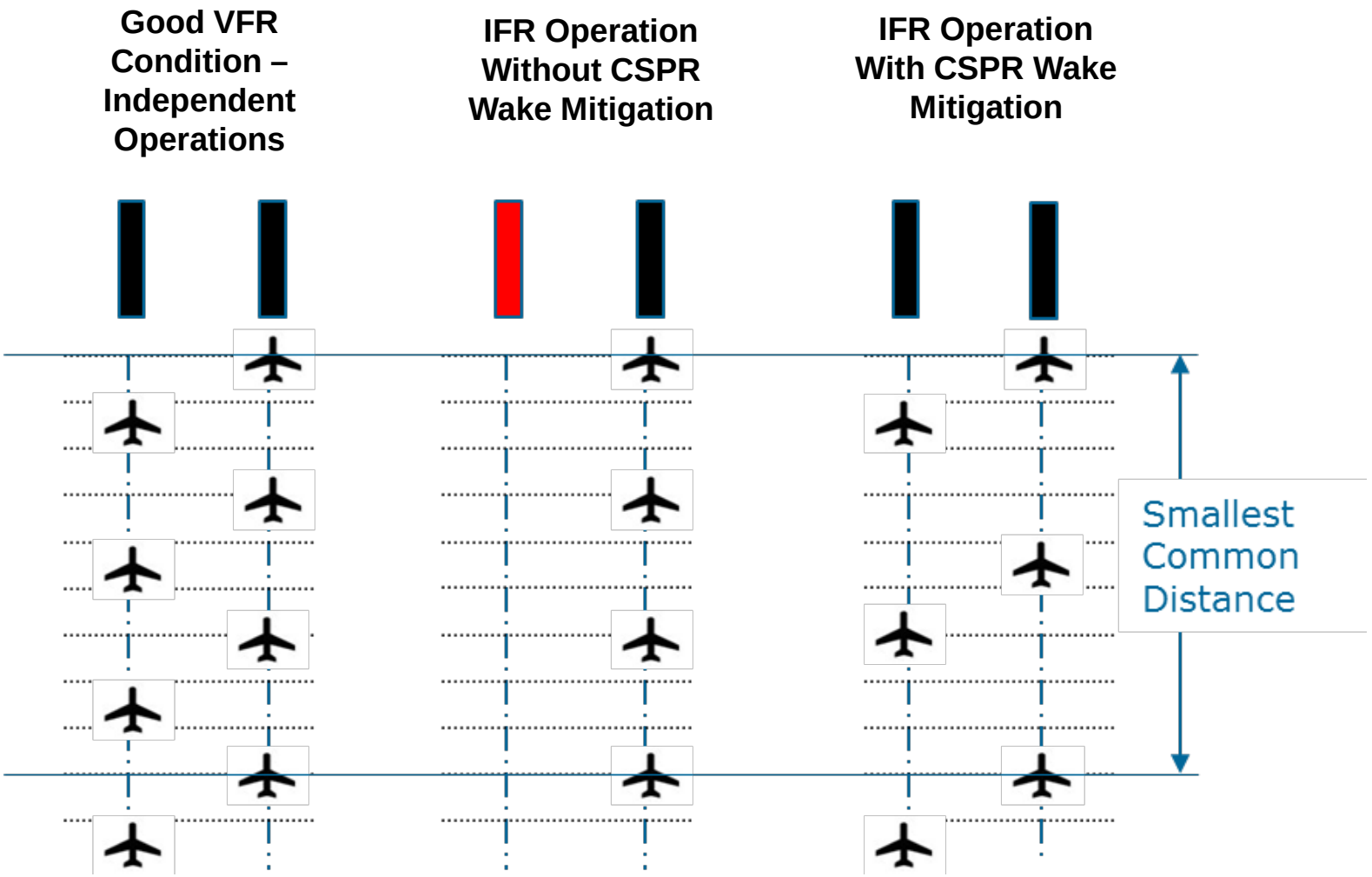
- Background
  - Why CSPR?
  - Past CSPR Efforts
  - Interface with Interagency and International R&D
- Updates
  - Present/Ongoing and Near term Future CSPR Efforts
  - Interfacing with Other Aspects of Wake Turbulence Efforts
  - Farther Term R&D

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



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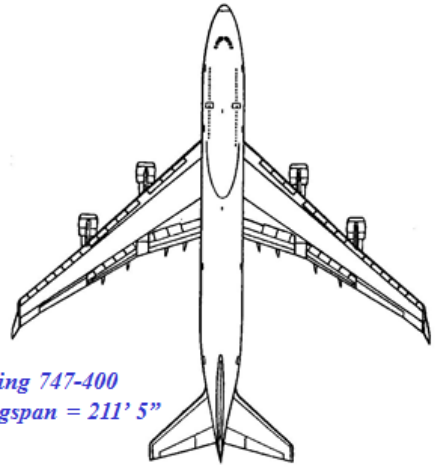
2500 Ft Rule

- 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)

Cessna 525A
Citation CJ2
Wingspan = 46’ 9”

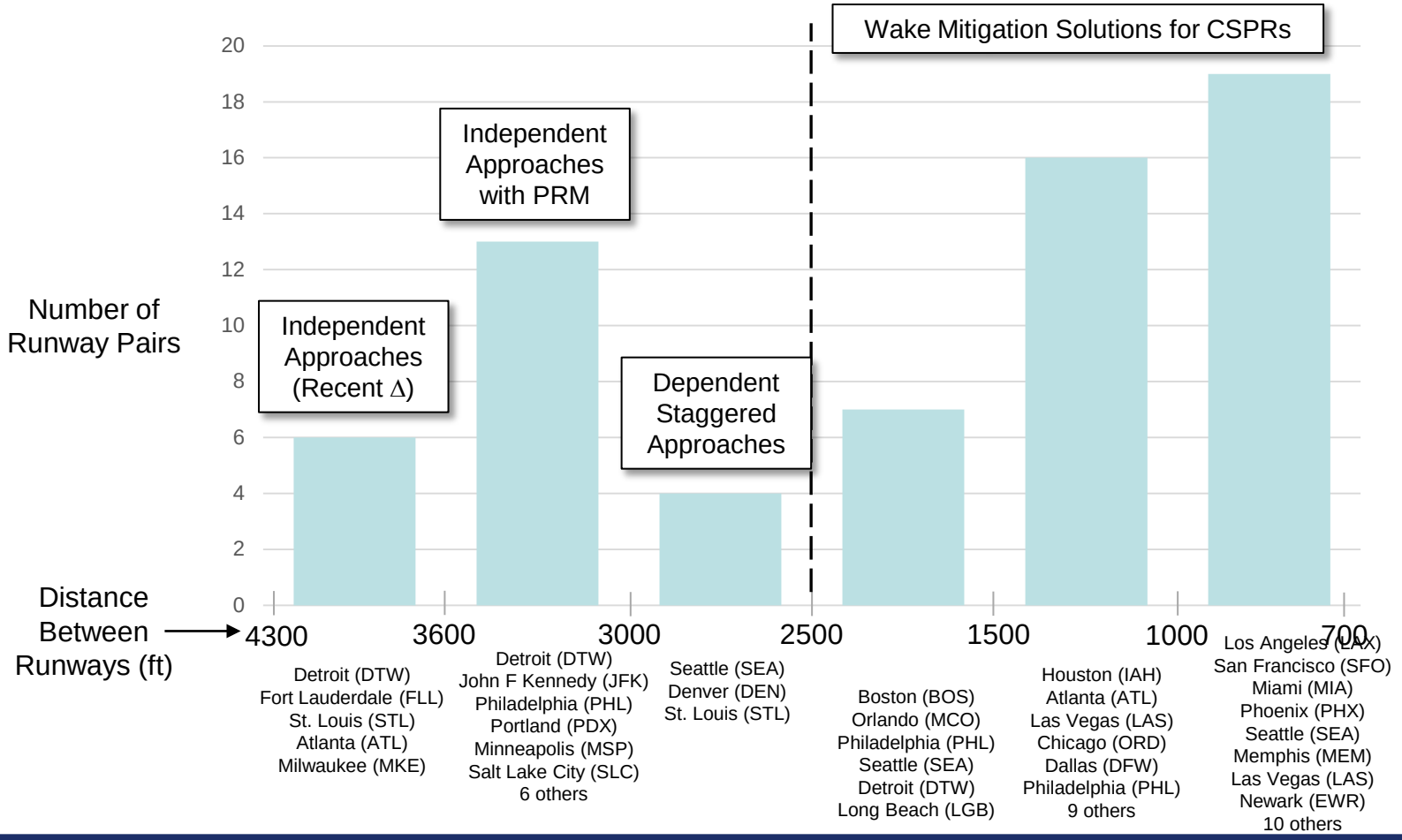


Boeing 747-400
Wingspan = 211’ 5”

2500 Ft Rule

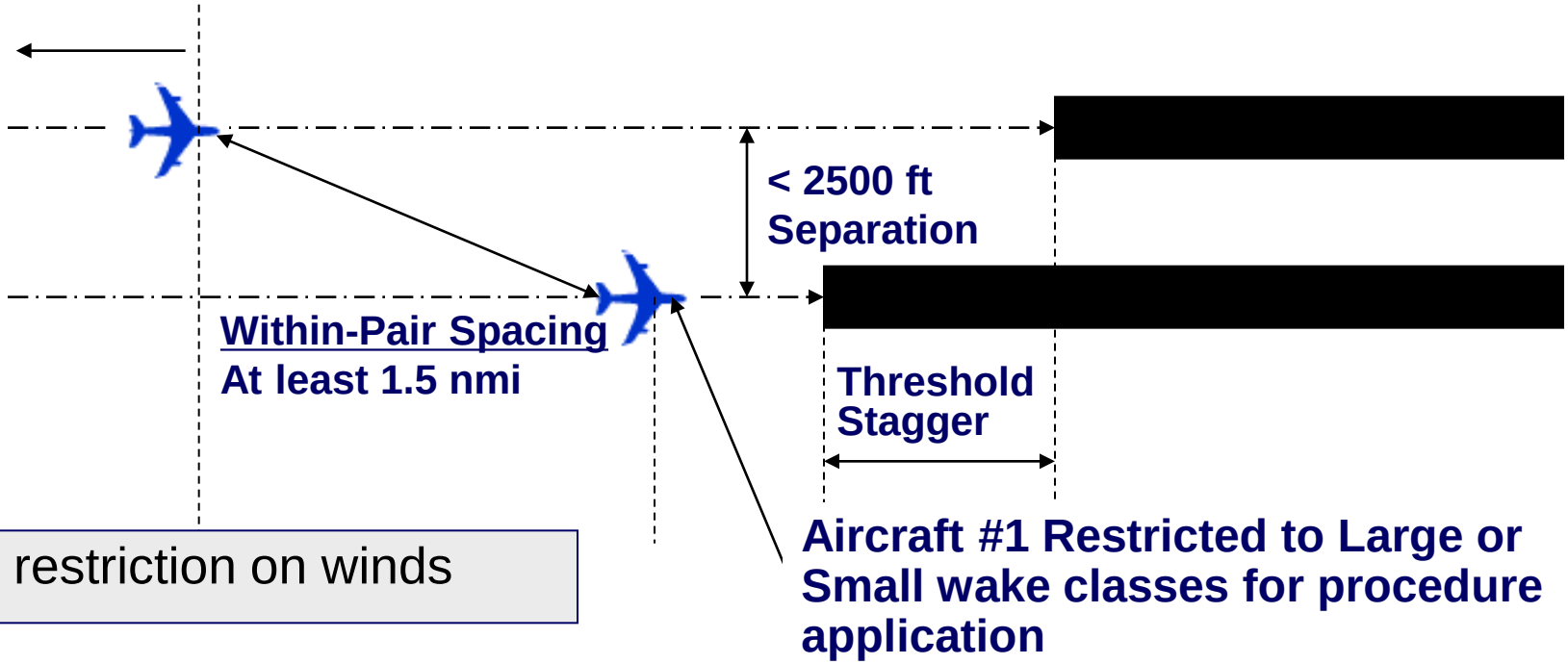
- Therefore, Opportunities Exist to Relax the CSPR 2500 Ft Wake Rule
- Identifying These Opportunities and Making More Efficient Use of CSPR Runways is a FAA NextGen Goal
- R&D Efforts Coordinated Across Multiple FAA Organizations
- Historical Note: Early FAA CSPR Wake Mitigation Solution Development Influenced by the Studies and Relative Safety Arguments in FRA HALS/DTOP

Why the US Investment In CSPR Solutions?



Staggered CSPR Arrivals - FAA 7110.308

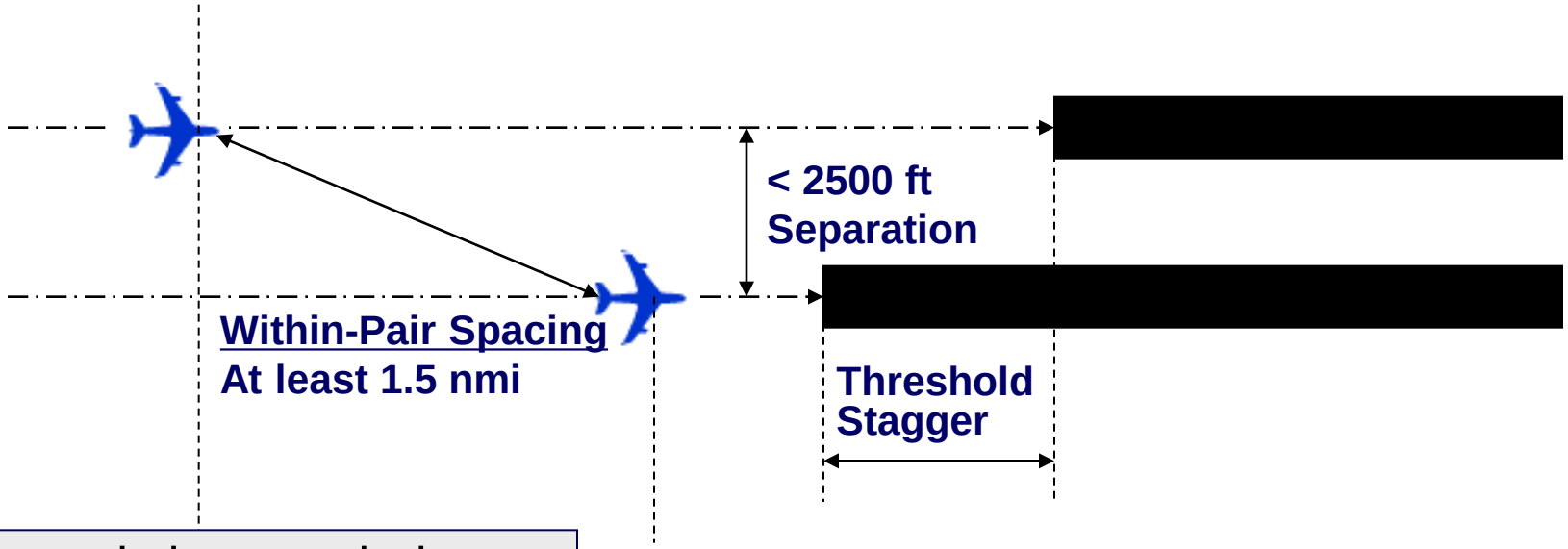
Aircraft #2 Any Wake Class Allowed
Current in-trail separation rules apply after #2



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



No restriction on winds

FAA 7110.308 Status


San Francisco Chronicle

SFO runway strategy limits weather delays

Michael Cabanatuan

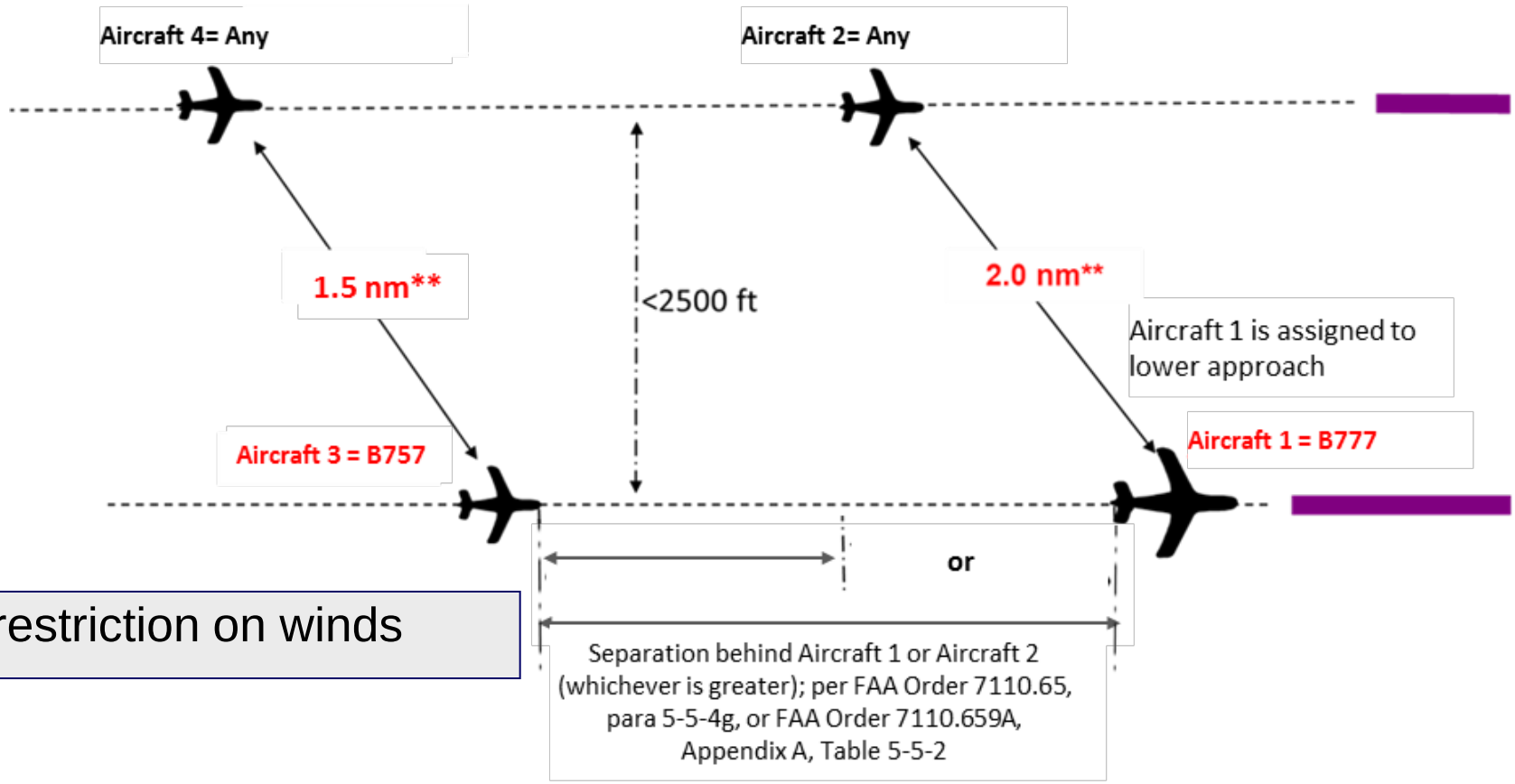
Updated 7:05 pm, Monday, November 4, 2013

- 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



No restriction on winds

**Notional diagonal separation

WTMA-P / 7110.308A Status

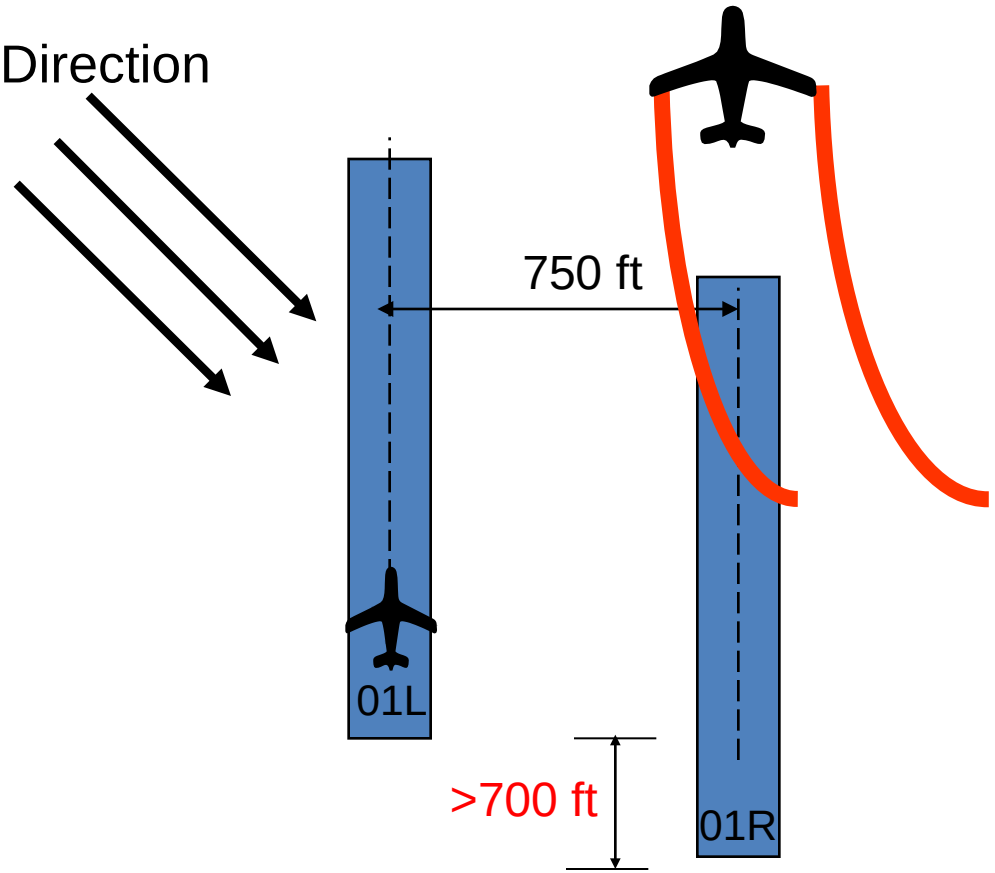
- The Safety Risk Management Document (SRMD) was approved December 2014
  - Assesses Risk for Hazards Related to the WTMA-P
  - Provides Analysis, Proposed Separation, and Implementation Options for PHL and DTW.
  - Allows Expansion of Analysis to More Sites in the Future, Similar to the Phased Implementation 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

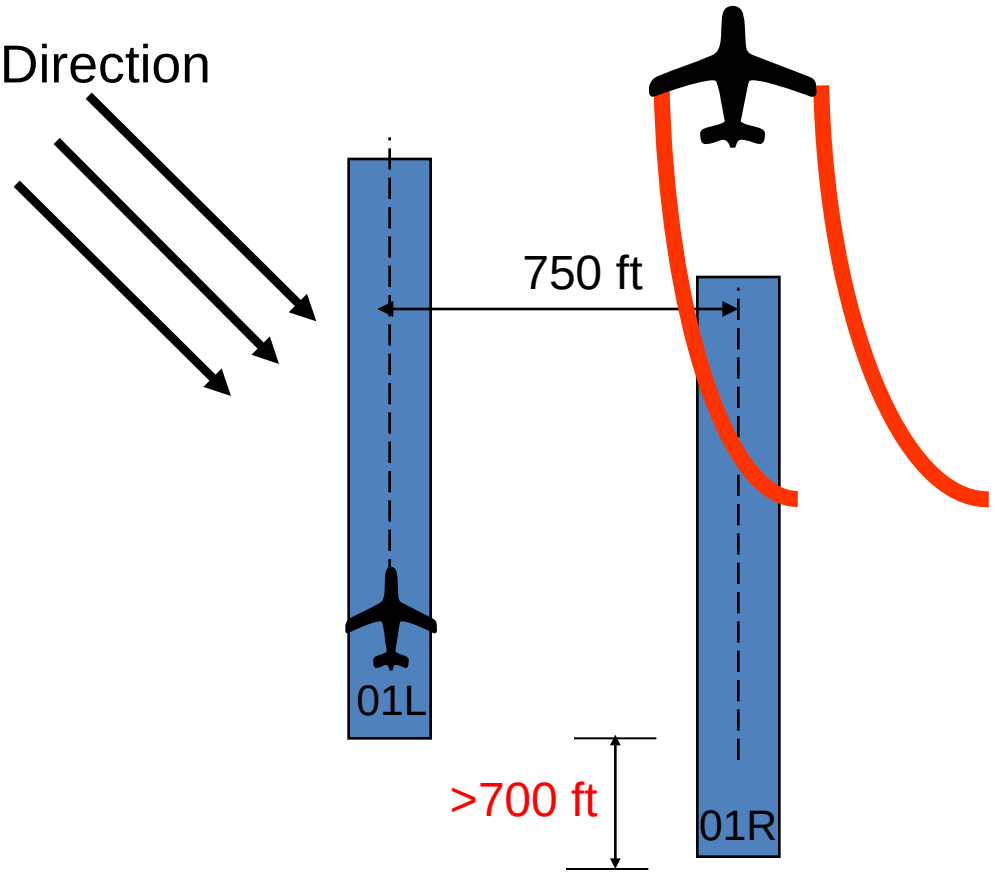
Without / Before WTMD

- 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

WTMD / 7110.316 Status - SFO

- 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

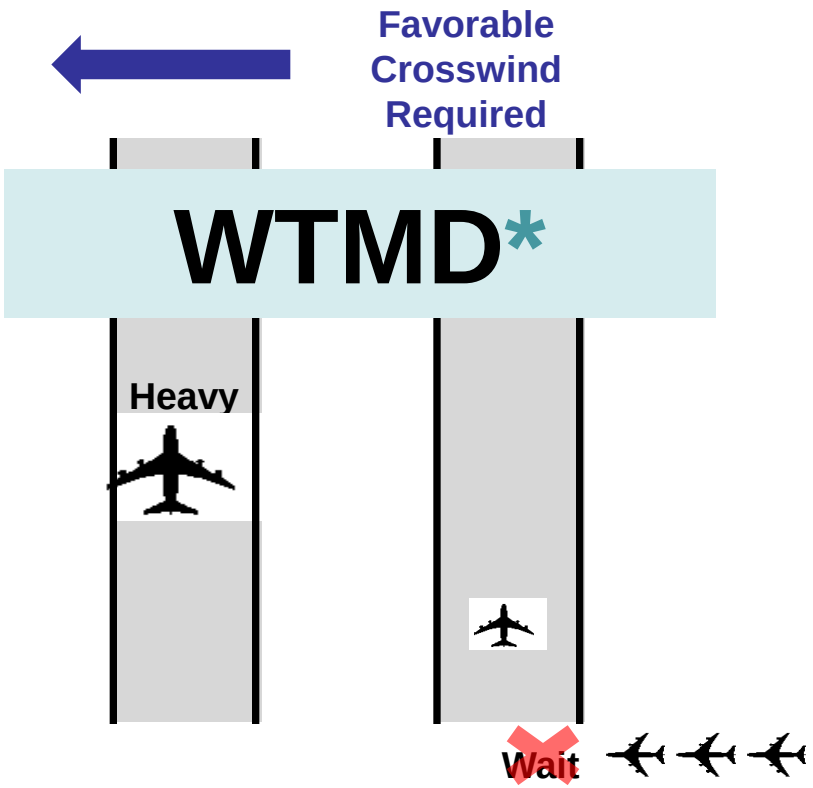
- To Provide Additional Availability/Benefit for Wind Based CSPR Departure, Wake Turbulence Research Office is Examining Elements of Concepts Originated from FAA NextGen / CSPO (Closely Spaced Parallel Operations) Efforts.
- WTMD-PD (WTMD-Paired Departure) is One Such Concept

WTMD-PD

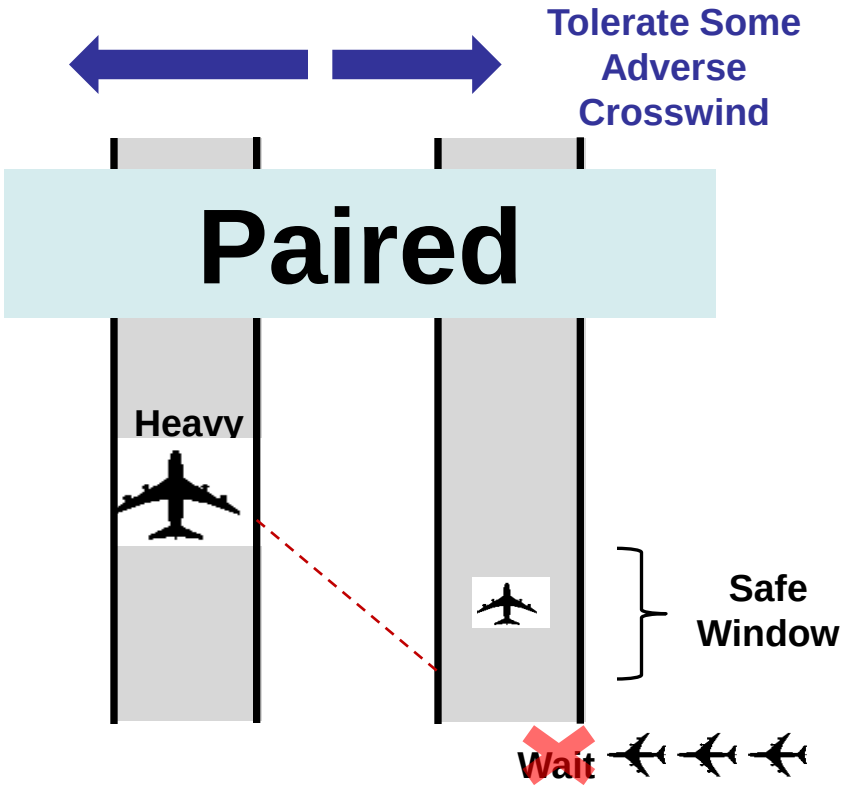
- Instead of Waiting for Wind Conditions to Keep the Wake Away, Depart the Trailing Aircraft Before Wake From the Lead Aircraft Has Time to Transport to the Trailing Aircraft Flight Path
- Takes Advantage of WTMD Algorithms and Infrastructure Already Established with Only Minor Modifications
- Has Potential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

WTMD vs. WTMD-PD

Predict "wake free" periods



Predict "wake free" windows



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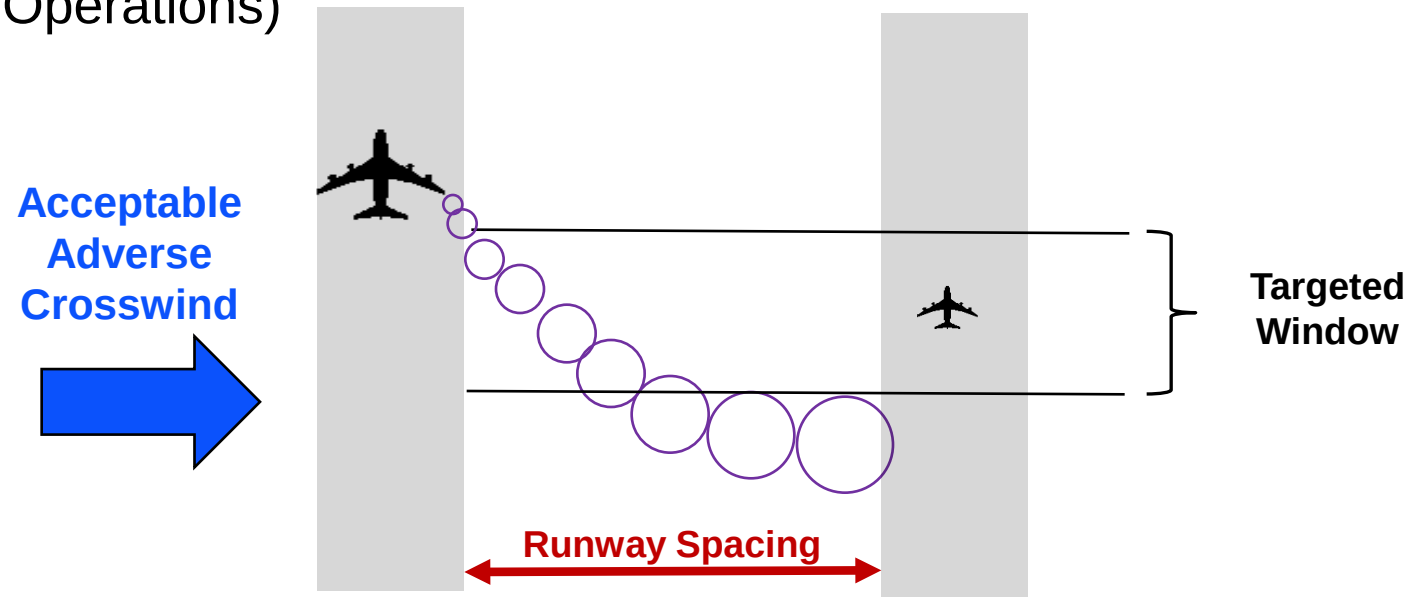
WTMD-PD

- 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)



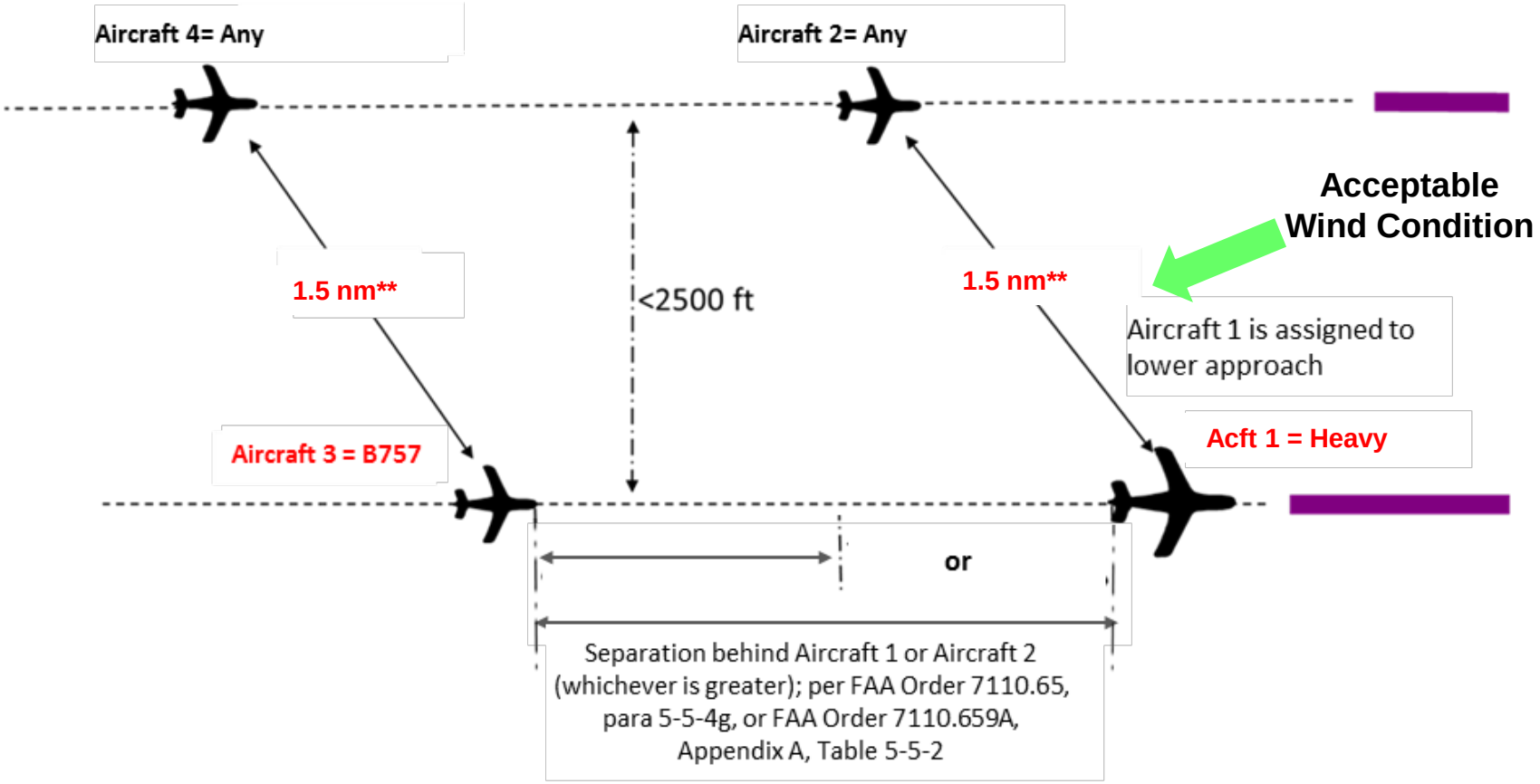
WTMD-PD Status

- 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)

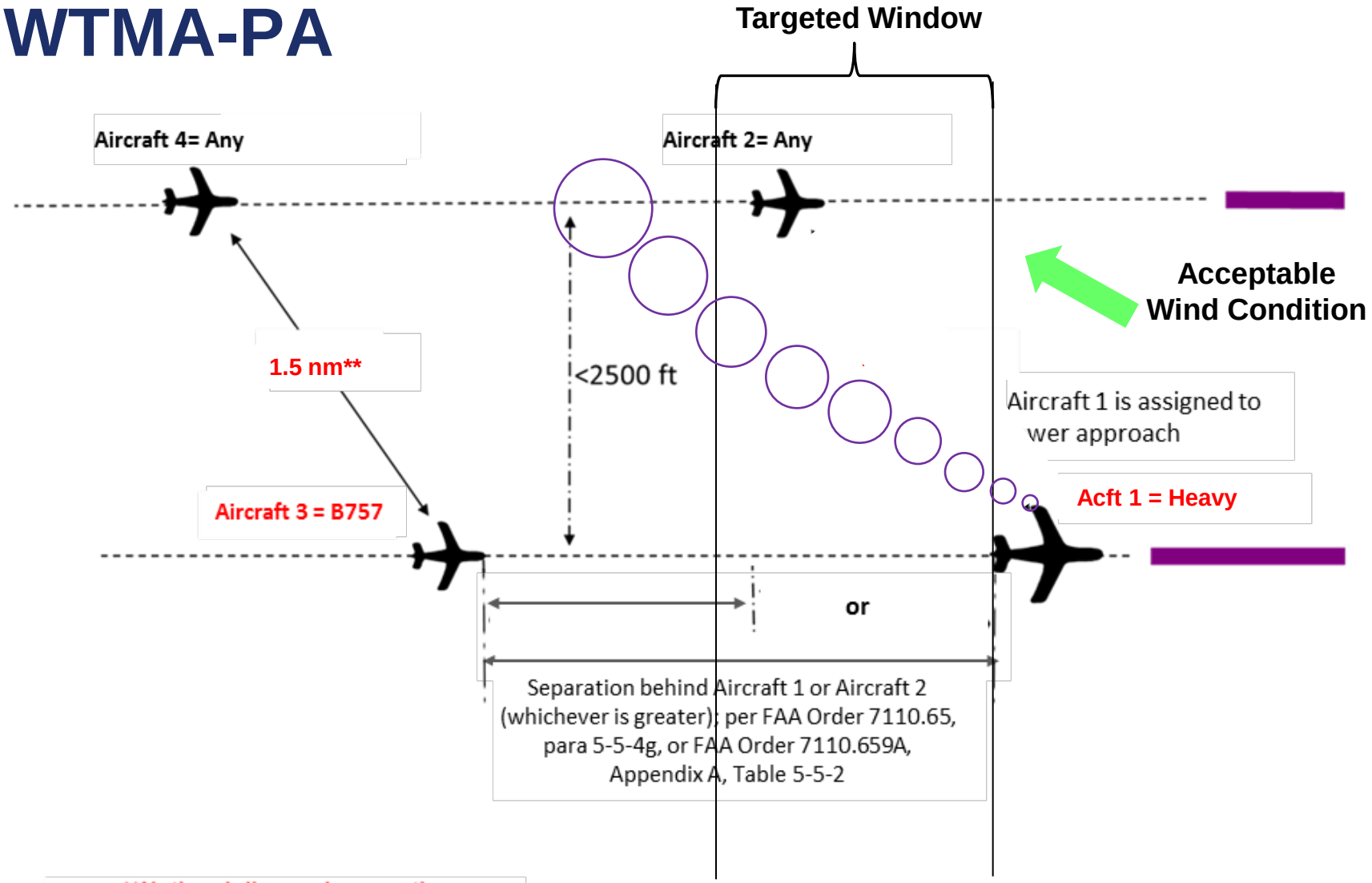
- WTMA-S Was Originally Envisioned as a Follow on to WTMA-P
  - “S” Stands for System
  - Arrival Analogue to WTMD
- Given Recent Proposed Changes to WTMD, Changes to WTMA-S Should Also be Considered
- Need to Define the Distance Needed for the CSPR Follower to Stay Ahead of the Wakes from Aircraft on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

WTMA-S



**Notional diagonal separation

WTMA-PA



**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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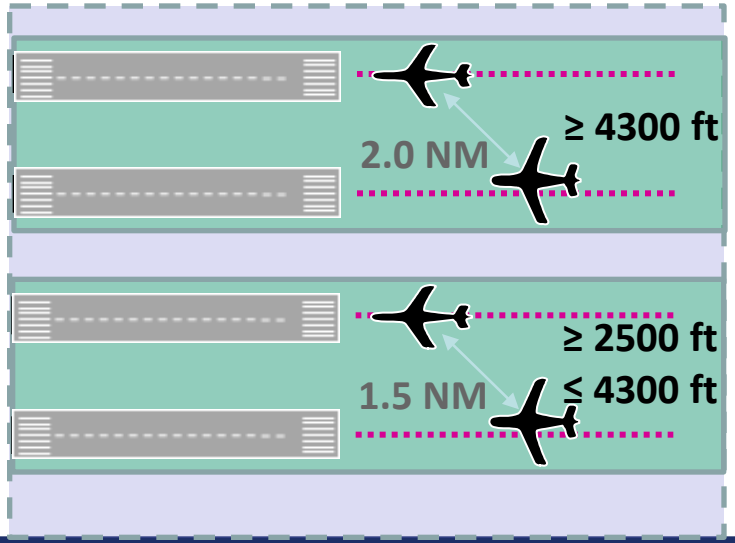
  - Farther Term R&D

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

Current



Objective

Dependent Approaches

Dependent Approaches for CSPRs