NAS Operations Portfolio Review

FY17 Portfolio: NextGen Wake Turbulence (A12.a) and Wake Re-Cat (1A05C)

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Federal Aviation Administration

Wake Turbulence (R&D) Program Overview

- Prior to 2000, FAA had a long history of wake turbulence research that did not provide capacity enhancements to NAS Operations
- In 2002, the focus shifted to operational impacts, which has led to significant capacity enhancements in the NAS by:
 - Providing cost effective airport throughput capacity benefits to NAS users
 - Without requiring new runways to be built
 - Without aircraft equipage requirements
 - Setting safe, capacity efficient wake separations for new aircraft series
 - Impacting the planned capacity benefits of NextGen mid to far term capabilities (Improved Multiple Runway Ops, Separation Management)



Major Topics to be Covered in These Two Project Briefings

- Project Description
- Why This Project is Necessary
- Accomplishments Benefits Delivered
- Research/Development Underway in FY15
- Research/Development Planned for FY16 & FY17
- Project Funding Profile
- FAA Response to REDAC Recommendation



NextGen – Wake Turbulence R,E&D Project A12.a



NextGen - Wake Turbulence R,E&D Project Description

- This RE&D provides WT research that matures Ops concepts to the point they can be developed and implemented through F&E
 - Supports NextGen objective to accommodate increased demand (flights) during peak demand periods
 - Provides access to airport runways and airspace while maintaining or enhancing the flights in today's NAS

• The outputs from this project

- Operationally relevant wake and wx data in situ from the surface up to ~2000 ft AGL
- Analyses of the data for direct application in the regime it was collected
- Models of aircraft generated wake turbulence for use outside of regime the data was collected
- Safety analyses for procedural solutions (e.g., 7110.308)



Why This Project is Necessary

- Provides the wake research for the FAA (ATO, ANG, and AVS) to satisfy its mission of service
 - Products to date that are based on this research include
 - 7110.308 (SFO 11% capacity gain)
 - RECAT (10-20% capacity gain for MEM, SDF, CVG, ATL, IAH and NY area March 1 2015)
 - WTMA (approved for PHL, DTW with 3-8 additional arrivals per hour anticipated)
 - Products to be delivered from this R&D project will similarly provide airport throughput capacity benefits to NAS users without requiring major investments by NAS users



Why This Project is Necessary (continued)

- Provides the wake research for the FAA (ATO, ANG, and AVS) to satisfy its mission of service
 - NextGen mid to far term products (IMRO, Separation Management) require wake solutions to deliver their full throughput capacity benefit
 - Time based separation wake separations must be considered
 - Interval Management requires wake encounter consideration
 - Products from IMRO (e.g., 1 NM diagonal separation) can be incorporated into CSPR wake procedures (7110.308, WTMA)
 - FAA/aircraft manufacturers/air carriers/airports require this program to establish safe, efficient wake separations for new aircraft prior to entry into service (NTSB recommendation 94-56)
 - To date: A380, B748, A350, B787
 - Upcoming: A320 neo. B77X



National Rule Change 7110.308

Accomplishments

- Airports currently approved: STL, BOS, CLE, PHL, SEA, EWR, MEM SFO
- SFO is achieving 35 arrivals per hour, and increased called rate from 30 to 34 per hour
- Aided SEA in handling capacity loss due to east most runway shut down (2011)

FY15 activities

- Authorization for use of RNAV for Boston 4L
- Order update to incorporate WTMA-Procedure at PHL, which will allow Heavy / B757 aircraft to participate in dependent approaches to CSPRs spaced <2500'

FY16/17 planned activities

- Site specific analysis for authorization at additional sites (up to 2 per year, depending on ATC requests or WTRO priorities)
 - Potential sites for .308 / WTMA-P analyses include BOS, EWR, MIA, SEA, SFO (19's), MDW, and SJC



Separation per single runway approach requirements of paragraph 5-5-4.e, f and g

Parallel Dependent ILS/MLS Approaches



Defining Wake Standards for New Aircraft

600

500

400

100

0

50

100

150

(m^2/s)

Accomplishments

- Data driven assessments were used to determine safe ATC wake separations for A388 and B748
- Modeling and comparative analyses were used for B787, A350, and smaller (B-737-8) aircraft series
- Initial A320-Neo analysis completed

FY15 Activities

- Determine final ATC wake separations for A320 Neo aircraft
- Start work on initial assessment of B777X, to identify if there is a need for data driven assessment
- Gather design information on Embraer E-2 and B737 Max series aircraft for setting wake standards

• FY16/17 Planned Activities

- Determine ATC wake separations for Embraer E-2 and B-737Max
- Initial assessments of TBD new aircraft planned for entry into service





small following heavy

large following heavy heavy following heavy

A350-800

Circulation vs. Time for A350 and Comparable

Aircraft (FAA)

Develop Models, Data Bases, Data Sources

Why do we need more wake data collection?

- Fleet mix will change over time, changing the capacity-impacting aircraft
 - RECAT Phase II optimization of TRACON wake separation standards will be driven by the ability to understand the wake characteristics of this evolving fleet
- Future benefit depends on it
 - Dynamic pairwise separation standards have additional data requirements

Accomplishments to date

Data collection has enabled successful safety cases for 7110.308, RECAT, WTMD, and more

• FY15 Activities

- Continue research to collect aircraft performance characteristics (e.g,B₀)
- Gather pilot reported wake encounter data

• FY16/17 Planned Activities

- Enhance wake turbulence data collection suite with a refresh of its measuring and data processing technology
- Revision of en-route aircraft wake turbulence generation fast time model including use of data collected from Canadian NRC en-route wake measurements
- Reprocess wake transport and decay measurement data with improved analysis tools to reduce uncertainty buffers utilized in setting wake separation standards



Absolute Criteria for Wake Encounter Risk

All safety assessments to date have been conducted using a relative risk assessment

- Today is acceptably safe, but may be conservatively so
- Relative Risk assessment constrains wake severity and encounter likelihood for proposed change to be no greater than today
- Absolute criteria are necessary (e.g., for dynamic separation) to maximize capacity gains

Accomplishments

 Developed initial tool for data mining thousands of aircraft flight data recordings for potential low impact (not reported) wake encounter events

• FY15 Activities

- Continue severity data collection using OKC flight simulators
- Add more aircraft types to flight data recorder screening tool

FY16/17 Activities

 Gather low impact wake encounter frequency data from screening archived flight data recorder data



Dynamic Wake Separation

Transition from static wake separation to dynamic standards

- Static standards account for worst case conditions (i.e. conditions that lead to long lasting wakes)
- Dynamic wake standards consider environmental and atmospheric factors which may enable wake decay or transport

Accomplishments

 Established, in RTCA documents, the need for aircraft observed weather to be broadcast on a frequent basis

• FY15 Activities

 High level assessment of dynamic wake separation concepts and their potential benefits above those achieved via static separations

• FY16/17 Planned Activities

 Develop prototype time based (rather than distance based) controller decision support tool information display for monitoring wake separation

• FY18+

- Develop and evaluate prototype algorithms that use downlinked aircraft flight information to adjust required wake mitigation separations between aircraft (FY18)
- Collaborate with SESAR on RECAT Phase III dynamic separation standards



Paired Procedures

- Paired Approach and Paired Departure concepts allow for expansion of WTMD and WTMA-S wake turbulence mitigation concepts by providing increased procedure availability
- Accomplishments
 - Concept explorations for Paired Approach and Paired Departure concepts complete
- FY15 Activities
 - Detailed feasibility and benefit analysis of changing WTMD procedure to include a provision to stay ahead of the leading aircraft wake. Initial study shows increase in the WTMD procedure availability for ATC use going from 14 % to 70%

• FY16/17 Planned Activities

 Provide relative wake encounter risk assessments of proposed interval management ATC procedures





Project Funding Profile – A12.a

(\$M)

FY15	FY16	FY17	FY18	FY19	FY20	FY21	Beyond
8.5	8.6	8.8	8.6	8.8	9.0	9.2	TBD

 The wake data collection equipment suite is approaching a decade of use and will require overhaul/replacement. The \$1M reduced funding of the A12.a beginning in FY14 has caused the project to delay its equipment overhaul/ replacement multi-year program – putting at risk the needed continued collection of wake data for use in reducing the measurement error buffers that will be part of the Re-Cat Phase III wake separation standards



NextGen – Wake Re-Categorization (RECAT) Project 1A05C



Federal Aviation Administration

RECAT Project Description

- RECAT addresses one of the major constraints on runway throughput capacity:
 - Develops reduced wake separations based on data driven safety cases
 - These separation reductions increase airport throughput and in some cases simplifies ATC procedures
 - Defines requirements for ATC automation to implement the capacity enabling standards and processes (automation enhancements implemented through F&E)
- It is achieving increases in airport runway throughput capacity without additional investment by the aviation community
- Near-term: (Phase I) rebalancing of aircraft categories in wake standards to fit current airport fleet mixes in some of the top 10 airports in the NAS
 - Successful at MEM, SDF, CVG, ATL, IAH and NY (EWR, JFK, LGA)
 - Is not designed to be implemented across the NAS
 - Phase II permits more tailoring to fleet mixes and is intended for NAS wide implementation



RECAT Project Description (cont.)

- RECAT Phase II wake separation standards provide airport optimization of benefit:
 - Provides flexibility in the number of aircraft categories and aircraft assignments to those categories based on local (TRACON) fleet mix
 - Provides a 4 to 7% increase in runway throughput capacity above Phase I
 - Key site operational in FY17
- RECAT Phase III wake standards eliminate use of aircraft wake categories:
 - Minima wake spacing between aircraft will be determined dynamically by aircraft performance and in-flight weather
 - Feasible approach and estimate of throughput capacity increase are being explored (potential 4 to 7%)
 - NATS near term implementation of Time Based Separation is an example of this kind of capability



Why This Project is Necessary

- Produces products requested by users (for which there is an operational need)
 - RTCA Task Force 5 report
 - FAA & NextGen Advisory Committee's "NextGen Priorities Joint Implementation Plan" submitted to Congress (10/2014)
- Continuation of this project will provide NAS users
 - Another 4 to 7% runway throughput capacity increase via the completion of the RECAT Phase II standards
 - Potentially another 4-7% throughput increase via the completion of RECAT Phase III standards and supporting infrastructure



RECAT Phase I Accomplishments & Benefits Delivered

- FAA Order 7110.659A "Wake Turbulence Recategorization" developed and approved (6/2014) – allows implementation across the NAS
- The RECAT Phase I standards key site implementation at MEM (11/2012) – Now at SDF, CVG, SDF, ATL, IAH, and NY (EWR, JFK, LGA):
 - FedEx at MEM estimates savings of approximately \$1.8M per month
 - UPS at SDF estimates 52,000 lbs of fuel saved per night
 - Delta at ATL is estimating Re-Cat Phase I at ATL is saving them \$14.8M (low side) to \$38.1M (high side) each year in operating costs







Source: FedEx Air Traffic Operations

RECAT Phase II Accomplishments

- RECAT Phase II standards developed in collaboration with EUROCONTROL
 - As with Phase I, politics got in the way (A388)
 - Agreement was reached on 88% of the pairwise separations for the 117 by 117 matrix of aircraft types currently operating in the world
- EUROCONTROL is pursuing the A388 centric Phase I solution
- FAA is committed to approval and implementation of US proposed Phase II solution
 - Pairwise separations completed
 - Safety case work with Panel currently underway
- Harmonization still possible at an ICAO level
 - FAA can commit to international standards that deviates slightly from US proposed solution
 - Eurocontrol will need to show the same flexibility



Development Underway in FY15

- RECAT product development was not funded in FY15
- The NAS Ops Subcommittee addressed this lack of funding with a Finding and Recommendation last March



REDAC Finding – Wake RECAT

- **Recommendation:** The Subcommittee recommends that FAA estimate the annual benefits of RECAT Phase I at the airports scheduled for implementation in FY 2015 and use this estimate in its decision making on how to allocate budget cuts among the NextGen F&E budget line items. To this point, FedEx estimates an 18% improvement in throughput at MEM. While this benefit will scale according to unique attributes of traffic at other airports, this gain has significant potential value through expanded implementation. The Subcommittee encourages FAA to identify whether there are alternative means to continue translating the outcome of its wake turbulence research into achieved benefits, balancing these efforts with other priorities for procedures and airspace improvements.
- <u>FAA Response</u>: This recommendation, in conjunction with recommendations from the NextGen Advisory Committee (NAC), led the FAA to perform benefits and ops analyses to develop a waterfall of airports for RECAT implementation, along with a resource allocation plan to support the waterfall



REDAC Finding – FAA Response NextGen Priorities Join Implementation Plan



• All Recat Phase 1 implementations beginning in FY15 are funded from non-NextGen funds (Ops or ATO F&E)



Activities Planned for FY16/17

- Implementation at 12 TRACONS, per NIWG commitments (non-NextGen funding)
- Development of modifications to ATPA Phase 1 and Flight Data systems for the RECAT Phase II airport specific wake separations
- Develop RECAT Phase II ATCT and TRACON training
- Conduct RECAT Phase II key site evaluations
- Resume coordination with EUROCONTROL on RECAT Phase III concepts and development schedules (need to get beyond A388 political issues)



Project Funding Profile – 1A05C

(\$M)

FY15	FY16	FY17	FY18	FY19	FY20	FY21	Beyond
0	1.5	1.8	2.5	2.5	0	0	0

- RECAT development activities resume in FY16
- RECAT project funding will be necessary in FY19 and beyond for the following:
 - RECAT Phase III wake separation standards, ATC procedures and associated safety risk management documentation developed and submitted for approval
 - Necessary modifications to NAS automation systems and information networks developed
 - RECAT Phase III key site evaluations conducted to determine if RECAT Phase III delivers sufficient benefit to NAS users to merit NAS wide implementation







Federal Aviation Administration

NARP Milestone Summary NextGen – Wake Turbulence (R,E&D)

Year	Milestone	Status	Notes
2014	Provide wake separation recommendations for Airbus 350 series aircraft	Completed	2014 NARP Status: On schedule
2015	Complete safety analysis for Phoenix and Las Vegas airports to support potential use of the 7110.308 procedures for their closely spaced parallel runways, pending operational need.	Completed	Changes reflect the completion of safety analysis research for PHX and LAS which can support the SMS process for updates to 7110.308. However, this update is currently on hold pending determination of the operational needs of the service providers to make use of the 7110.308 procedure at these sites. Therefore, the research activities are complete, while ATO operations need assessment is ongoing. 2014 NARP Status: On schedule
2015	Evaluate air traffic control procedures for providing wake mitigation separations between unmanned aeronautical systems and piloted aircraft	On schedule	
2015	Develop and assess readiness of statistics based wake encounter risk evaluation tool for use by FAA wake turbulence subject matter experts (SMEs) in evaluating NextGen Trajectory Based Operations flight routing procedures	On schedule	
2016	Develop the initial performance measures that will be used by the air traffic control terminal automation systems for dynamically setting wake separation minimum in the terminal airspace for each pair of aircraft	On schedule	Milestone was revised in order to focus on research yielding the highest benefit in the terminal airspace. Old wording: "Develop the algorithms that will be used in the Air Navigation Service Provider (and flight deck as needed) automation systems for setting dynamic wake separation minimum for each pair of aircraft" 2014 NARP Status: On schedule
2017	Develop prototype information display for the controller decision support tool used to allow reduced wake separations for instrument approaches to a single runway	On schedule	
2018	-Perform analysis in support of safety risk management documentation for Wake Turbulence Mitigation for Single Runway procedure.	On schedule	Milestone was revised to focus on Single Runway procedure. WTMA-S SRMD will be F&E funded (assuming funding is available). Old wording: "Produce the initial draft of a safety risk management document for the Wake Turbulence Mitigation for Arrivals – system" 2014 NARP Status: On schedule
2019	Submit a draft of the safety risk management document for Wake Turbulence Mitigation for Arrivals - system	Deleted	Milestone is deleted due to F&E funding plan for WTMA-S. 2014 NARP Status: On schedule
2019	Complete development of detailed operational concepts for dynamically modifying required wake mitigation separations	On schedule	New milestone
2020	Complete prototype enhancements to weather based forecast algorithms used by wake mitigation air traffic control decision support tools to enable use of real time weather observations from aircraft	On schedule	New milestone



NARP Milestone Summary Wake Turbulence – Re-Categorization (F&E NextGen Separation Management Portfolio)

Year	Milestone	Status	Notes
2014	Complete modifications to FAA Orders for Static 6 Category standards	Completed	
2014	Complete leader/follower pair-wise static standards development	Completed	
2014	Complete development of a set of enhanced process and procedure modeling tools to evaluate proposed pair-wise dynamic aircraft wake hazard mitigation procedures	Completed	
2016	Complete changes to FAA Orders for implementing Leader/Follower Pair- Wise Static wake separation standards	Not started	New milestone
2017	Complete application software adaptation and training for key-site implementation for Leader/Follower Pair-Wise Static wake separation standards	Not started	New milestone
2017	Complete concept feasibility description of dynamic wake separation standards	Not started	New milestone
2018	Complete high level analyses on feasibility and benefit of using dynamic wake separation standards	Not started	New milestone
2019	Develop detail descriptions of ANSP processes and procedures for use of dynamic wake separation standards	Not started	New milestone

