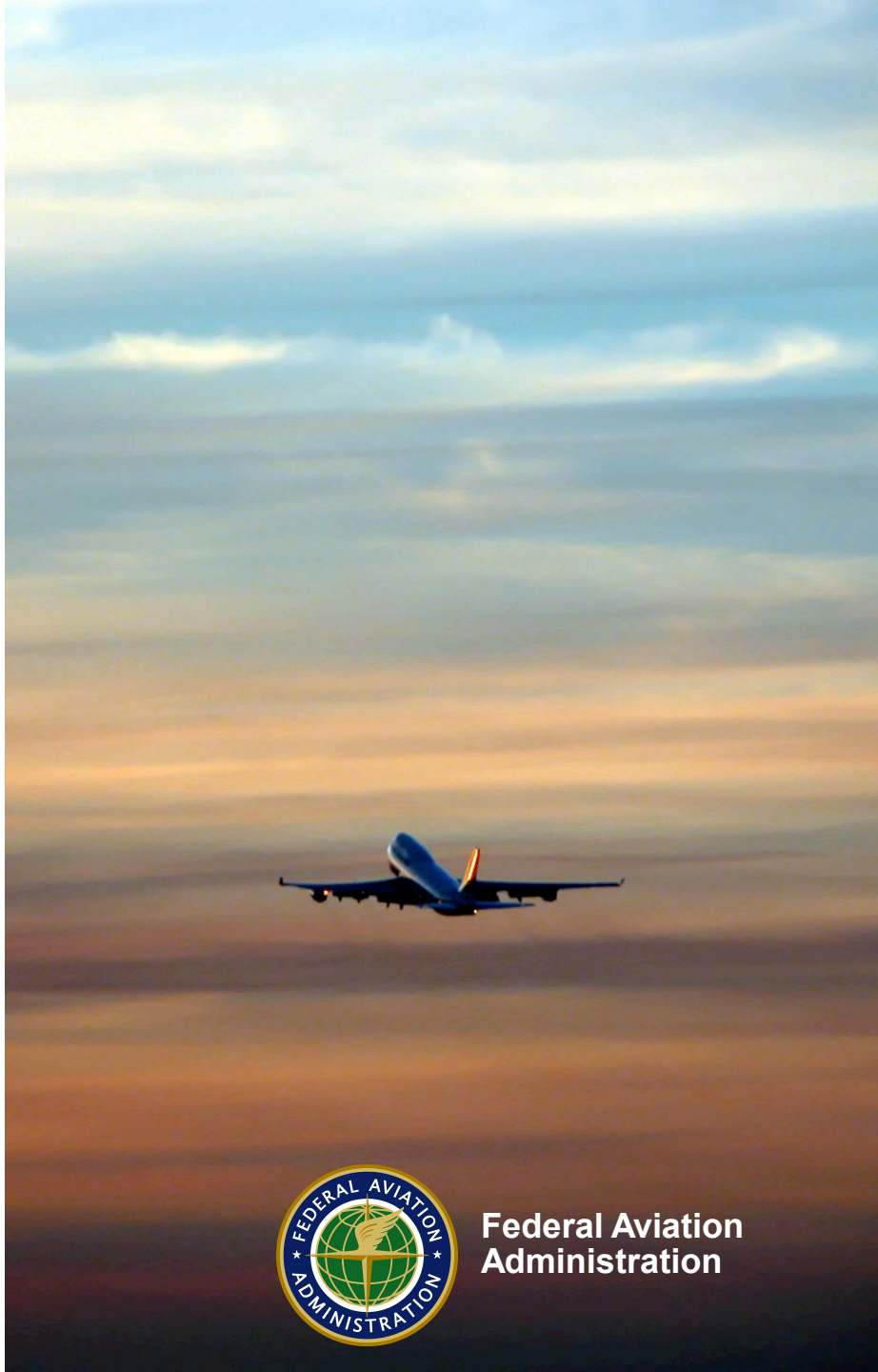
2018 REDAC Spring Meeting

Aircraft and Helicopter Operations Research

By: Chris Dorbian & Rick Riley

Date: March 8, 2018



Outline

1. The Aviation Noise Challenge
2. Fixed-Wing Operations Research
3. Helicopter Operations Research

Community Concerns

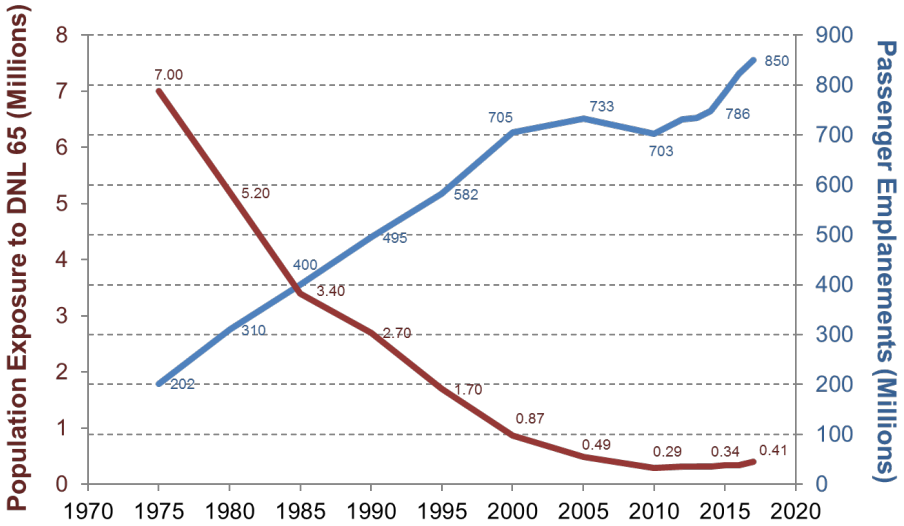
Dear FAA…

"Continuing NEXTGEN AND ignoring the health consequences RESEARCHED AND PROVEN by loud constant noise torture is a malicious action at this point. You have been contacted by MANY AFFECTED RESIDENTS AND CITIZENS making FAA aware of their suffering. … NEXTGEN = VANDALISM AND LEGALIZED NOISE POLLUTION"

""5:41AM, BOOM! Woken up by a [airline] plane arriving at [airport], 2,300 ft above my home. Horrible! But that's not the worst, it's only the beginning. 5:56AM another [airline] to [airport] 2,300 ft above my house. And then: 6:01am, 6:04am, 6:06am, 6:18am, 6:23am, 6:28am, 6:32am, 6:34am, 6:35am, 6:37am, 6:46am, 6:47am, 6:54am, 6:59am, 7:14am! It's 7:14am and I've already heard 16 planes since 5:41am. Please stop this insanity! Why are you allowed to rob me of my sleep, sanity and peace of mind?""

Current Challenge – Aviation Noise

- Despite traffic growth, community noise exposure has decreased by a factor of 20
- Yet, implementation of precision aircraft navigation over last few years has been accompanied by increased airport community concerns regarding noise
  - Rotorcraft noise also increasingly becoming an issue
- Community noise exposure now hindering the rollout of NextGen
- Aircraft are already much quieter – what can be done operationally?
- FAA is working to ensure that airspace planners have knowledge, tools, and guidance to enable low noise procedures



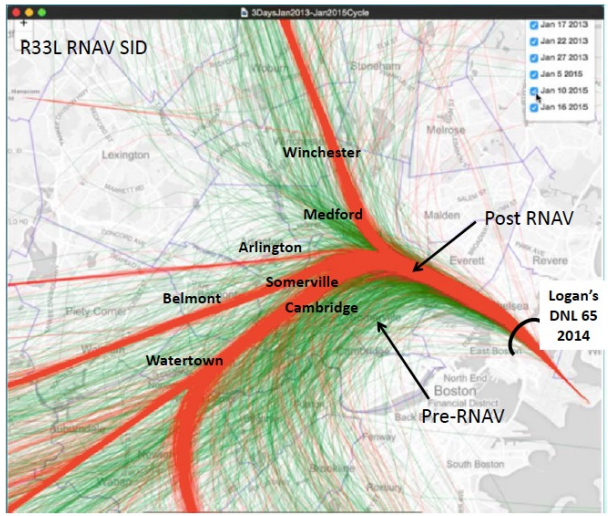


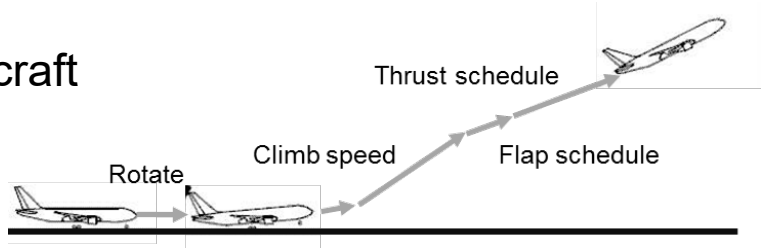
Image Source: Massport

Fixed-Wing Operations Research

Aircraft Operations

Opportunities for noise reduction:

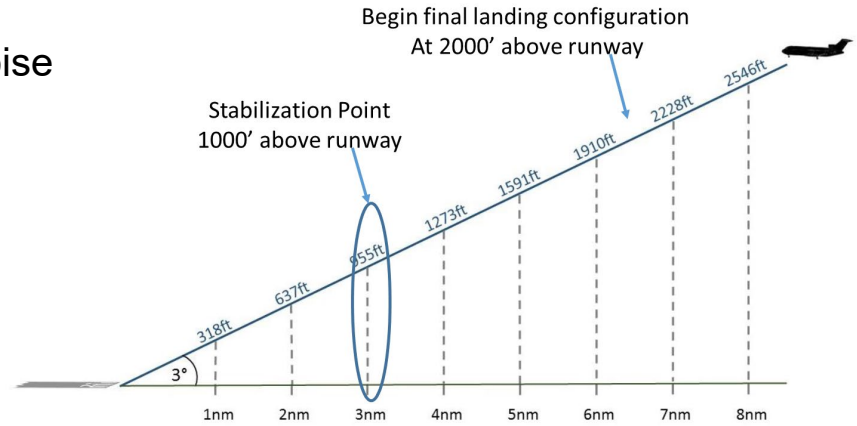
- Precision navigation determines *where* aircraft fly
- Airlines determine *what* aircraft fly and *when*
- There might be opportunities to change *how* aircraft are flown to reduce noise



Takeoff Profile

Concepts being evaluated:

- **Route changes**
- **Thrust / speed management**
  - Noise abatement procedures
  - Manage thrust and configuration to lower noise on takeoff and approach
- **Vertical profile**
  - Continuous climb operations
  - Continuous descent arrival
  - Modified approach angles
  - Staggered or displaced landing thresholds
- **Introduction of systematic dispersion**



Approach Profile

More Information:
ASCENT Project 023 website:
https://ascent.aero/project/analytical approach for quantifying noise from advanced operational procedures/

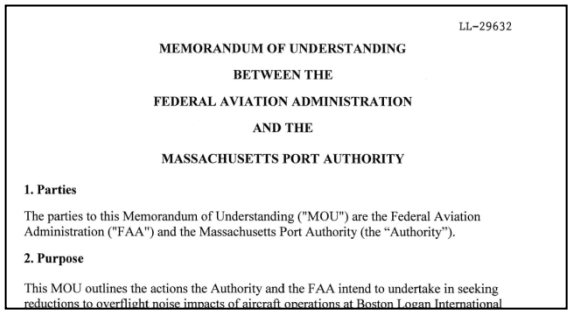
Federal Aviation Administration

Multiple Efforts Underway to Develop Noise-Abating Operational Procedures

ASCENT-23
Developed analytical framework for assessing operational procedures

AEDT
Development efforts underway to improve modeling capabilities

MIT



LL-29632

MEMORANDUM OF UNDERSTANDING
BETWEEN THE
FEDERAL AVIATION ADMINISTRATION
AND THE
MASSACHUSETTS PORT AUTHORITY

1. Parties

The parties to this Memorandum of Understanding ("MOU") are the Federal Aviation Administration ("FAA") and the Massachusetts Port Authority (the "Authority").

2. Purpose

This MOU outlines the actions the Authority and the FAA intend to undertake in seeking reductions to overflight noise impacts of aircraft operations at Boston Logan International

FAA–Massport MOU (BOS case study; FAA collaborative effort on Noise)

Industry/Gov't. Collaboration
- Industry collaboration (e.g., UPS, OEMs)
- Discussions with NASA underway

Knowledge, Guidance, & Tools/Options to Abate Noise

CLEEN Program (e.g., Flight Management System enhancements)

PBN Operations at Low Altitude (AJV / MITRE)

Application of ELSO and Open SIDs (ATR / MITRE)

Noise Abatement Procedure Usage and Effectiveness (ATR / MITRE)

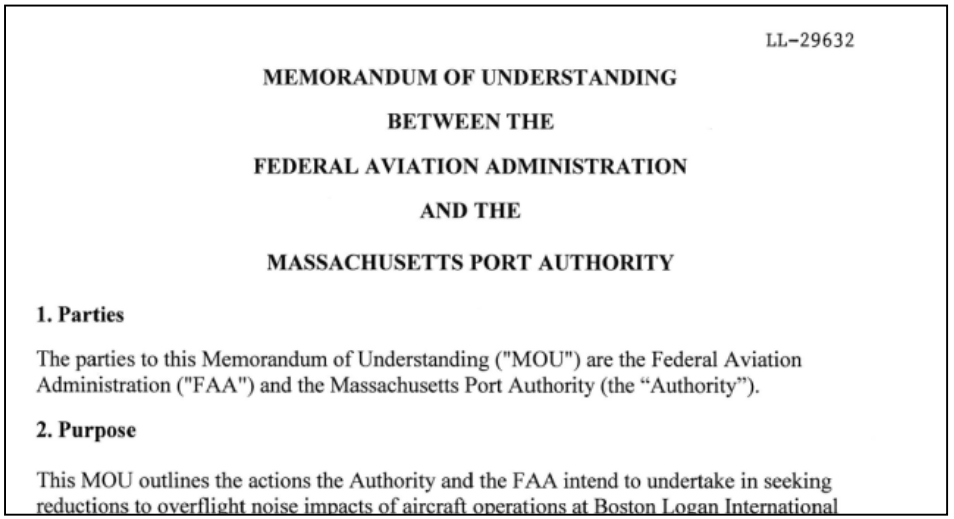
Steeper Noise Abatement Approach Operational Feasibility (ATR / MITRE)

ATR = Airport Technology Research (joint AEE/APP)

ASCENT Project 23 website https://ascent.aero/project/analytical-approach-for-quantifying-noise-from-advanced-operational-procedures/
AEDT website https://aedt.faa.gov/
Massport MOU https://www.faa.gov/news/updates/?newsId=86645
FAA CLEEN Program
https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/

Research Highlight: ASCENT-23 and Massport MOU

- MOU signed in September 2016 established framework for cooperation between Massport & FAA to explore operational changes to mitigate noise impacts
- E&E R&D program enabled MIT to develop noise evaluation framework (through ASCENT-23) and apply it (through Massport funding) to BOS to build and assess real procedures
- Massport submitted Block 1 proposal to FAA in December 2017
- FAA (primarily AJV Eastern Service Center and New England Region) now coordinating with Massport on plan for evaluating Block 1 concepts



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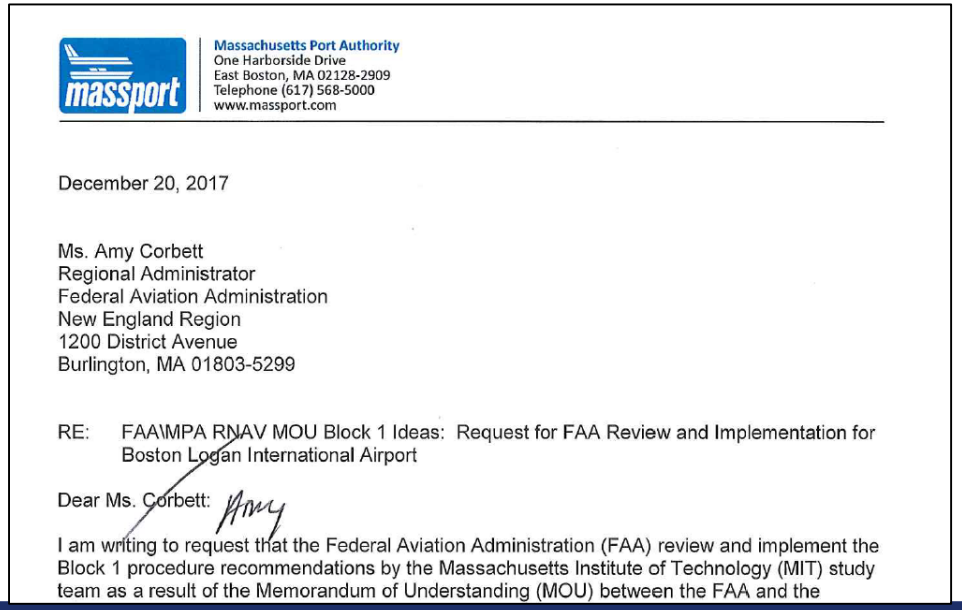


massport

Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128-2909
Telephone (617) 568-5000
www.massport.com

December 20, 2017

Ms. Amy Corbett
Regional Administrator
Federal Aviation Administration
New England Region
1200 District Avenue
Burlington, MA 01803-5299

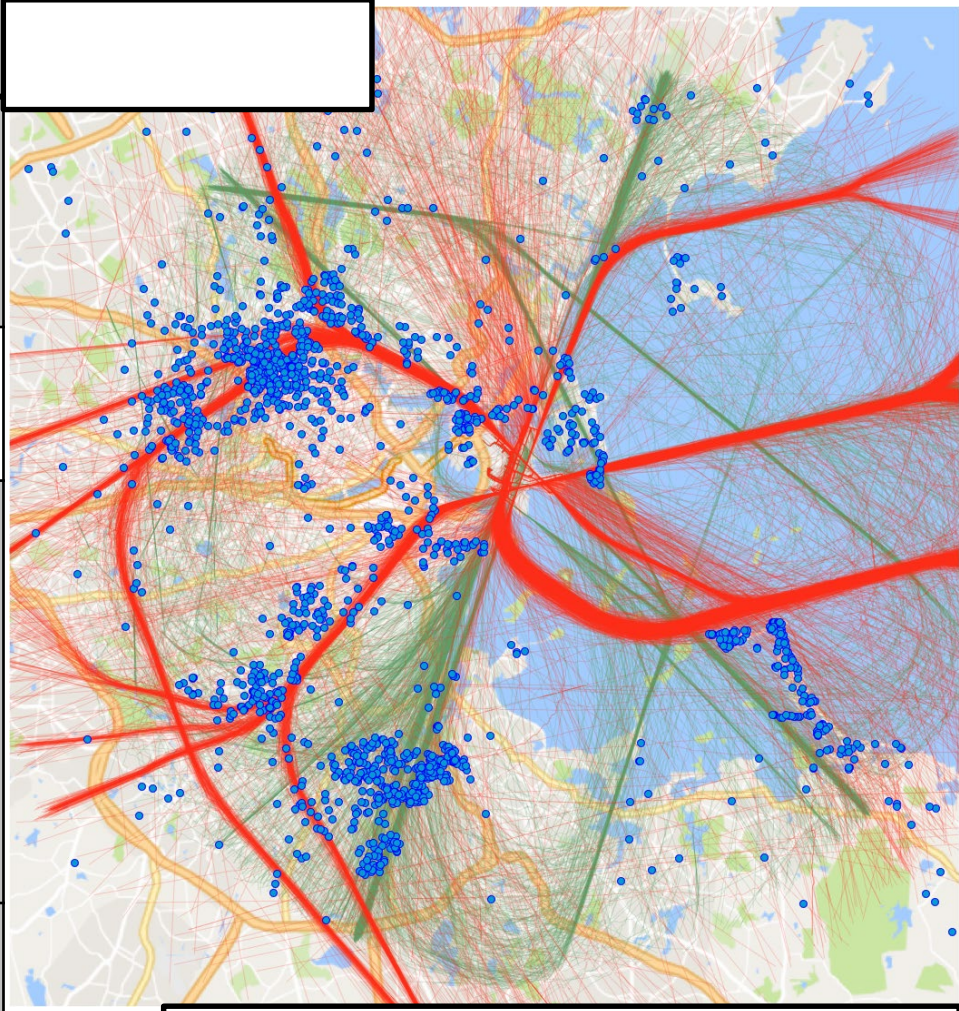
RE: FAA\MPA RNAV MOU Block 1 Ideas: Request for FAA Review and Implementation for Boston Logan International Airport

Dear Ms. Corbett:

I am writing to request that the Federal Aviation Administration (FAA) review and implement the Block 1 procedure recommendations by the Massachusetts Institute of Technology (MIT) study team as a result of the Memorandum of Understanding (MOU) between the FAA and the

Block 1 Final Recommendations

Proc. ID D = Dep. A = Arr.	Procedure	Primary Benefits
1-D1	Restrict target climb speed for jet departures from Runways 33L and 27 to 220 knots or minimum safe airspeed in clean configuration, whichever is higher.	Reduced airframe and total noise during climb below 10,000 ft (beyond immediate airport vicinity)
1-D2	Modify RNAV SID from Runway 15R to move tracks further to the north away from populated areas.	Departure flight paths moved north away from Hull
1-D3	Modify RNAV SID from Runway 22L and 22R to initiate turns sooner after takeoff and move tracks further to the north away from populated areas.	Departure flight paths moved north away from Hull and South Boston
1-D3a		
1-D3b	*Option B*: Climb to altitude, then direct (VA-DF) procedure	
1-D3c	*Option C*: Heading-based procedure	
1-A1	Implement an overwater RNAV approach procedure with RNP overlay to Runway 33L that follows the ground track of the jetBlue RNAV Visual procedure as closely as possible.	Arrival flight paths moved overwater instead of over the Hull peninsula and points further south
1-A1a	*Option A*: Published instrument approach procedure	
1-A1b	*Option B*: Public distribution of RNAV Visual procedure	

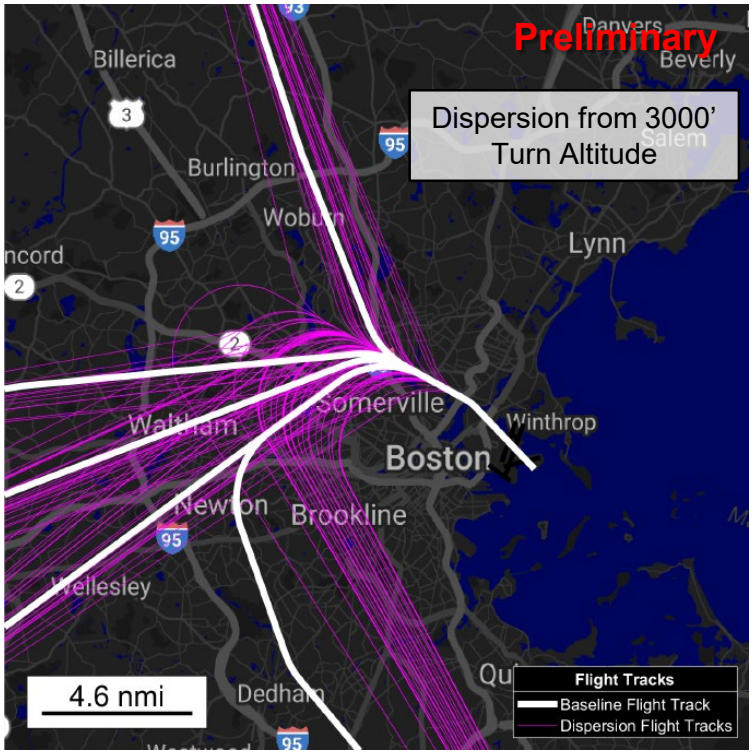


Track Data: ASDE-X from 12 days of operation, 2015-2016
Complaint Data: August 2015– July 2016
Each marker represents a unique complaint address

ASCENT-23 Future Direction

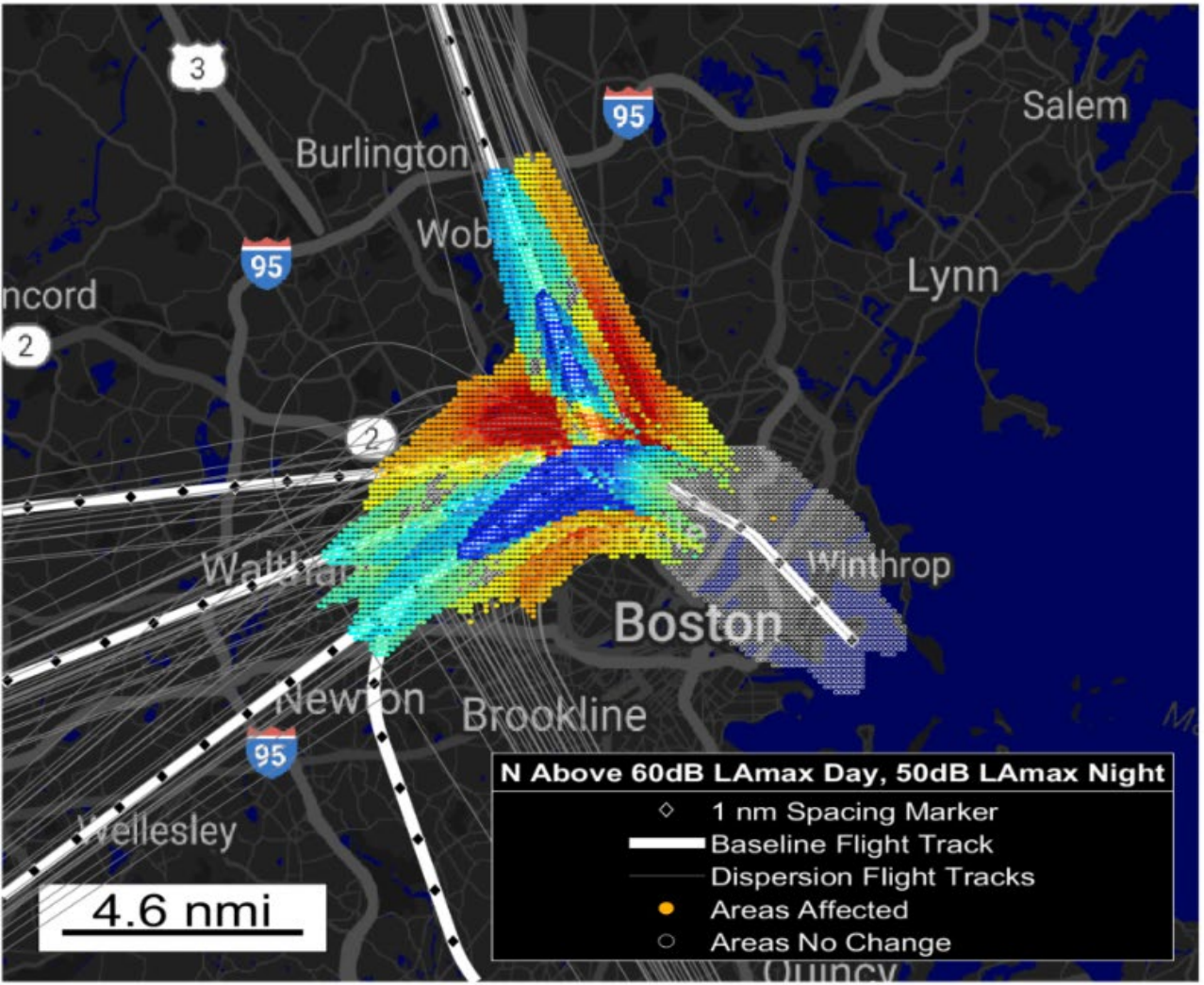
Research Questions:

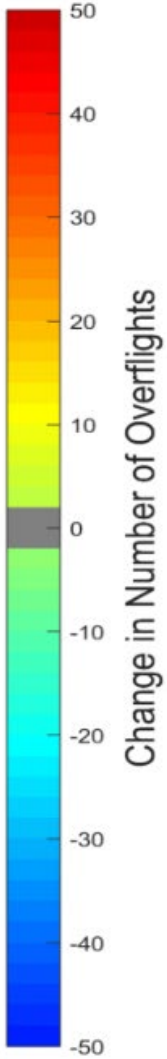
- How to evaluate/communicate the impact of dispersion?
- What does flexibility in procedure design criteria (e.g., final approach intercept angle / segment length) buy from a noise perspective?
- Are there other configuration/speed/thrust management opportunities?



For all of the above, what can be applied to wider NAS?

Example Approach for Evaluating Dispersion





N Above Levels:
60dB $L_{A,max}$ Day
50dB $L_{A,max}$ Night

Population Exposure

Change In N Above	Population Exposure
+50x	15,705
+25x	59,260
-25x	74,477
-50x	49,970

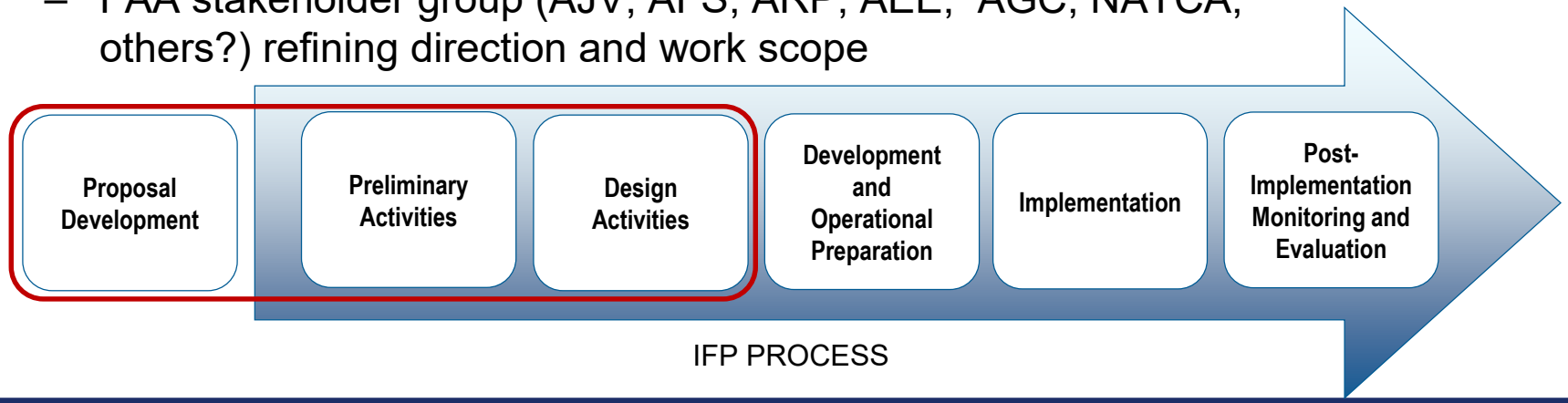
Preliminary example to evaluate methodology only. Should not be considered representative case.

ASCENT NFO: Validation of Aircraft Noise Abatement Procedure Modeling

- **Potential benefits of some concepts out of ASCENT-23 (e.g., reduced speed climb) are based on modeled results in ANOPP, which itself is based on measurements from the 1970s**
- **Detailed measurement campaign of real aircraft operations needed to assess the impact of aircraft speed, thrust, and configuration on noise**
- **Requirements:**
  - Experience in developing and modeling the environmental impact of advanced operational procedures
  - Capability to measure and analyze aircraft noise using high fidelity noise measurement equipment (e.g., phased array)
  - Partnership w/aircraft operator to access data
  - Coordination with NASA and other ASCENT projects

Other FAA Work: PBN Ops at Low Altitude (AJV / MITRE)

- **FY16: Dispersion Concept Identification; FY17: Concept Validation**
- **Conclusions:**
  - Complete information should be available to teams during design process
  - Guidance needed on mitigating noise at low levels that are outside FAA reportable or significant thresholds
  - Noise effects from PBN may be small and DNL may not be the most appropriate metric to capture changes
- **FY18: Refine, distribute, and operationalize best practices information (eventually guidance?) for procedure designers**
  - FAA stakeholder group (AJV, AFS, ARP, AEE, AGC, NATCA, others?) refining direction and work scope



Slide courtesy of The MITRE Corporation

Other FAA Work: Airport Technology Research (APP+AEE) / MITRE Projects

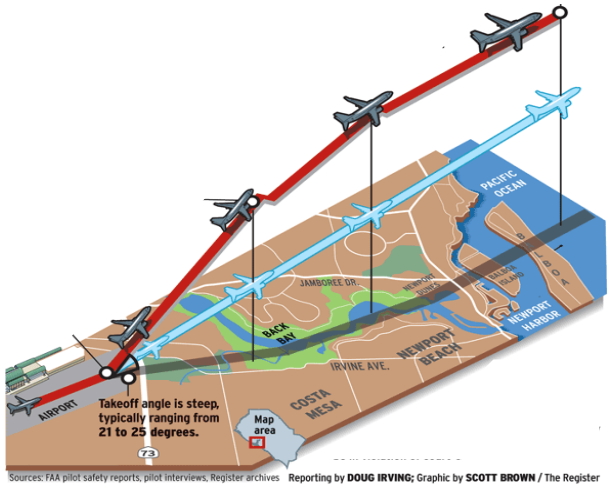
- **Noise Abatement Procedure Usage and Effectiveness**
  - Develop guidance which will lead to more effective and frequently-used noise abatement procedures

Runway Use	Departures	Arrivals
• Preferential/Calm Wind Runways • Nighttime Runway Use • Opposite Direction Operations • Rotational Runway Use	• Straight out/runway heading • Immediate turn/heading off runway • After initial routing • Nighttime procedures • Departure thrust cutback	• Approaches • Downwind Location • Nighttime procedures

- **Steeper Approaches**
  - Gain better understanding of the operational implications of implementing steeper approaches for noise mitigation

Questions Going Forward

- How do we operationalize research outcomes?
- How do we better incorporate noise into procedure design?
- How do we communicate the research and manage expectations within airport communities?



- How do we handle equity issues? What tools could help the decision-makers make better decisions? (noting that decision-makers could be local communities, local governments and/or the FAA)
- Are there additional areas that need consideration (potentially using FY18 or FY19 funds)?

Helicopter Operations Research

Noise Abatement Helicopter Operations (1 of 2)

MOTIVATION

- Rotorcraft noise is an increasingly contentious matter with the general public
  - Issues with Long Island North Shore, the LA Basin, the Grand Canyon, and Hawaii have become prevalent
  - These challenges effect helicopter operators in pursuit of businesses that meet demand
  - As the numbers of helicopters have increased, so has the number of complaints

GOAL

- Develop noise abatement piloting procedures for a variety (classes) of helicopters which can address these issues and make helicopter operations more acceptable

Noise Abatement Helicopter Operations (2 of 2)

APPROACH

- Develop and validate an accurate aero-acoustic prediction model for a variety of rotorcraft configurations to support development of these procedures
- Execute noise testing to establish noise abatement procedures data and apply for validation of modeling capabilities

ACTIVITES

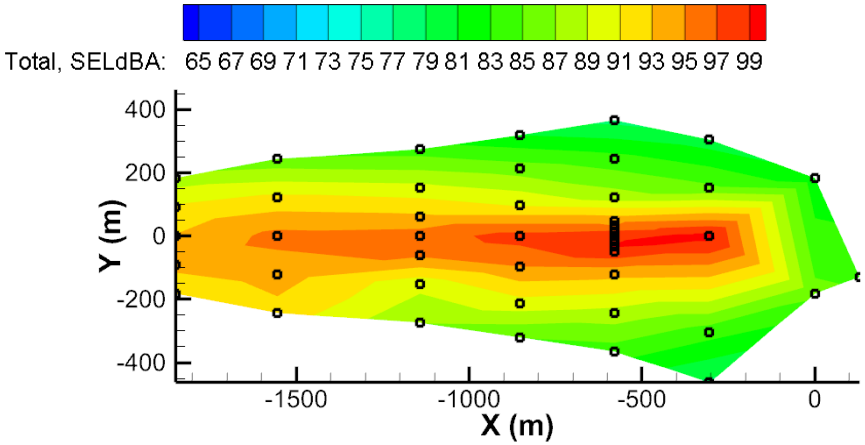
- PSU has developed a physics based model (PSU-WOP-WOP) which currently has the capability to predict steady state and turning rotorcraft operations
- A joint NASA/FAA noise test of six helicopters has recently been conducted and initial analysis of the results is in progress
- PSU is using results of the test to validate and improve the capability of PSU-WOP-WOP

NASA/FAA Noise Test

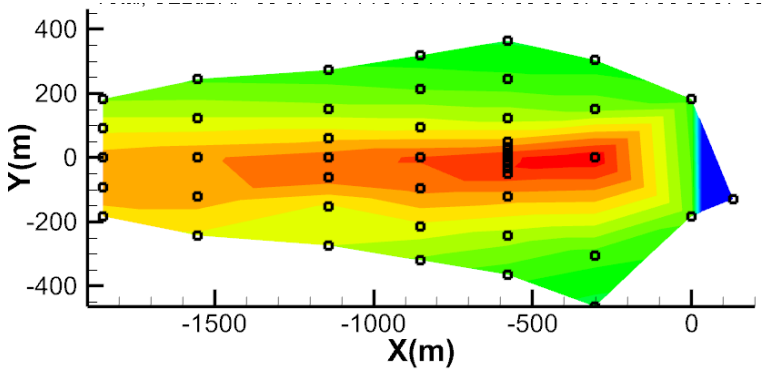
- The aircraft tested were selected to represent several categories of rotorcraft
- The categories tested included aircraft size, number of main rotor blades, difference in tail rotor technology, and difference in engine types
- The test rotorcraft were R-44, R-66, Bell 206LIII, Bell 407, AS350, and EC130

Initial Validation of PSU WOP-WOP Model

Bell 407 80kts 6 Degree Descent



Measured Results



PSU-WOPWOP Prediction

Noise Abatement Helicopter Operations

Progress to Date

- NASA has conducted an initial analysis of turning maneuvers
- This has led to some preliminary recommendations to reduce noise during turns such as accelerating and climbing versus descending and decelerating
- PSU has utilized data from the test to begin model validation
- This will lead to model refinement and finally a capability to develop and predict noise abatement procedures for current aircraft as well as proposed new designs

Future Work

- NASA will continue data analysis to develop noise abatement procedures and provide data for PSU model development
- PSU will continue to utilize results of test data to improve their model
- A “Heavy” category, such as a S-76 and S-92 needs to be flight tested to make available these procedures for largest rotorcraft in operation

Backup Slides

Physics-Based Noise Modeling Framework

Performance Model Inputs:
Operating/mission parameters
Aircraft sizing/performance parameters
Engine sizing/performance parameters

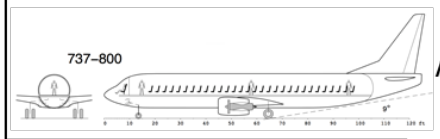
Aircraft Type

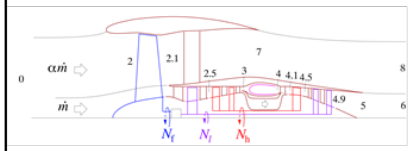
Procedure Definition:
Lateral Path
Speeds
Configuration

TASOPT

BADA4 Existing Aircraft Data

Performance Model Outputs:

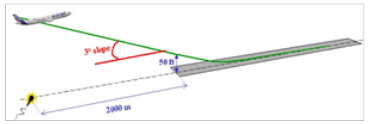




Aircraft/engine performance & geometry

Flight Procedure Generator

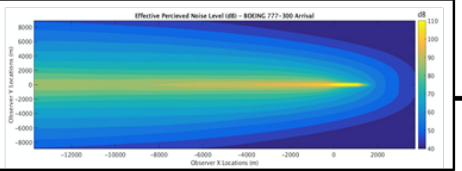
Flight Procedure:
Thrust, velocity, position, gear/flap settings per time



Noise Model Control Inputs:
Propagation Settings
Observer Locations

ANOPP

Single-Event Noise Grids



Output to Grid Rotation and Superposition