2020 REDAC Spring Meeting

Aircraft Operations for Reduced Noise

By: Chris Dorbian

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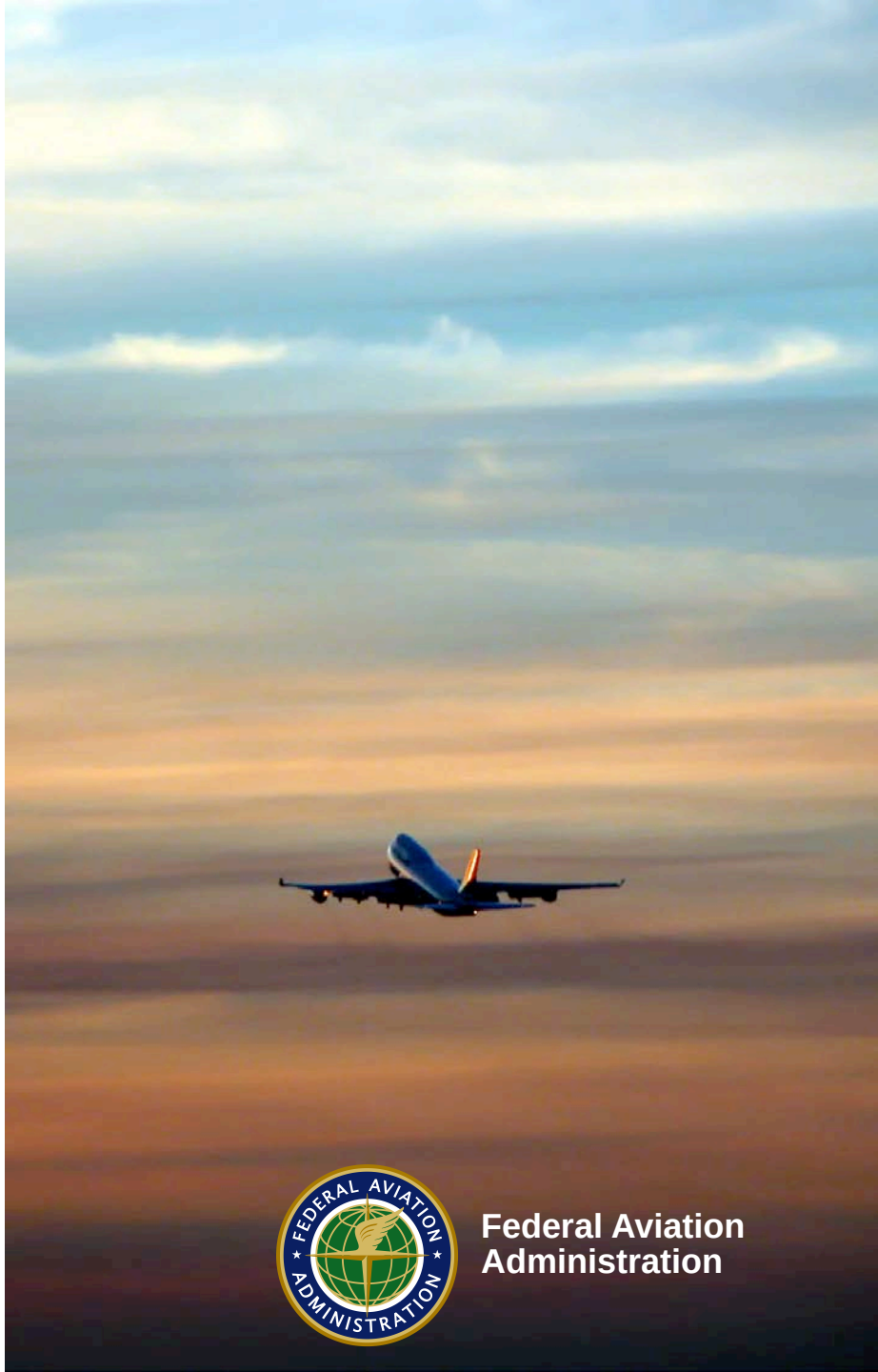


Federal Aviation Administration

FAA Efforts Relating to Aircraft Operations

1. Investigation of operational opportunities for noise reduction:

- Airlines determine *what* aircraft fly and *when*
- There might be opportunities to change *where* aircraft fly (through precision navigation) and *how* aircraft are flown
- Must consider the entirety of the airspace and ensure the continued safety of operations
- Concepts being evaluated:
  - Route changes
  - Thrust / speed / configuration management
  - Vertical profile modifications
  - Systematic dispersion

2. Validation of noise abatement procedures

- Operationally validate (through flight sim/testing, noise measurement, etc.) noise management concepts

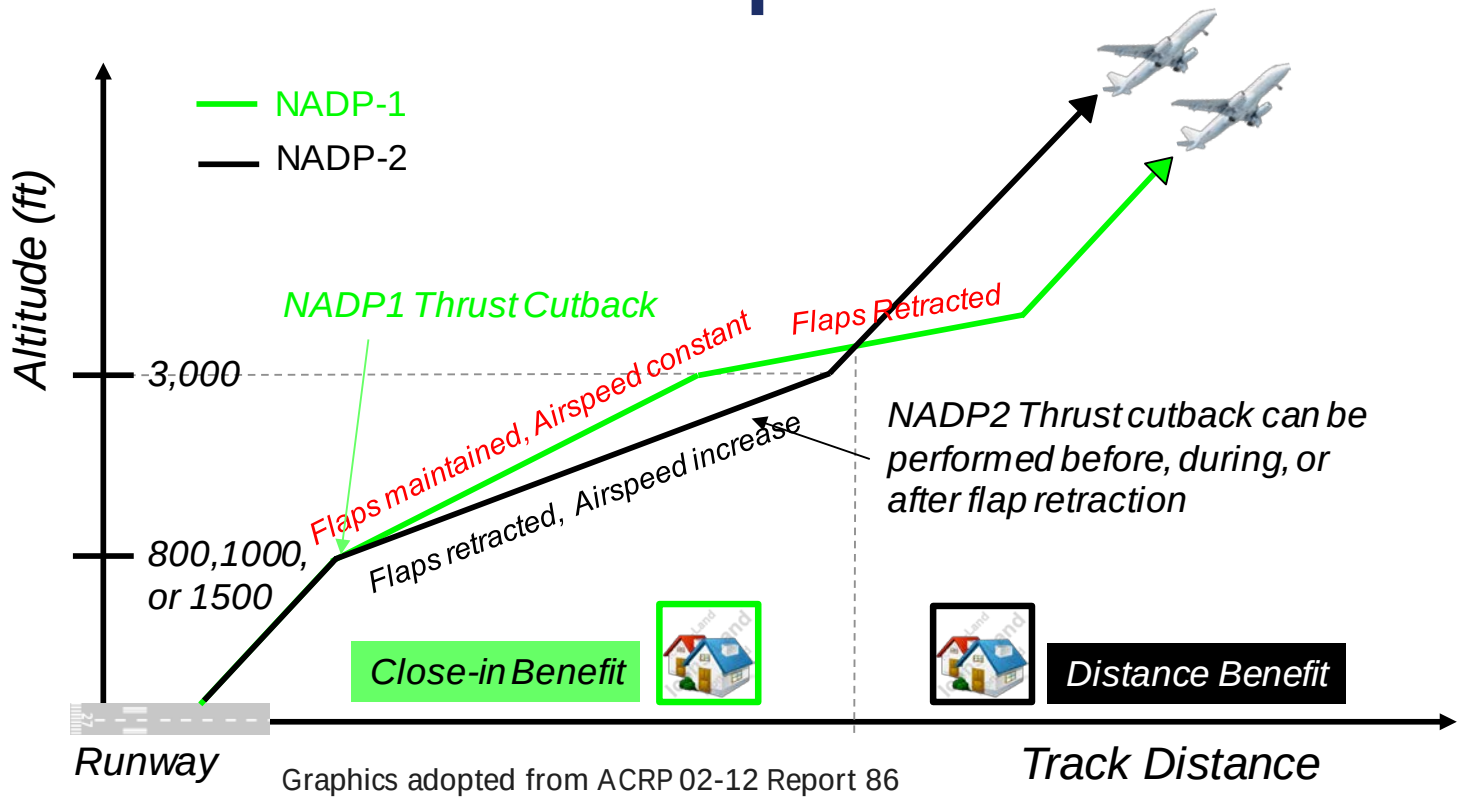
3. Advancement of tools, processes, and policies

- Execution of knowledge, guidance, & tools/options to manage noise

Reauth. Sec 179 Report Preview

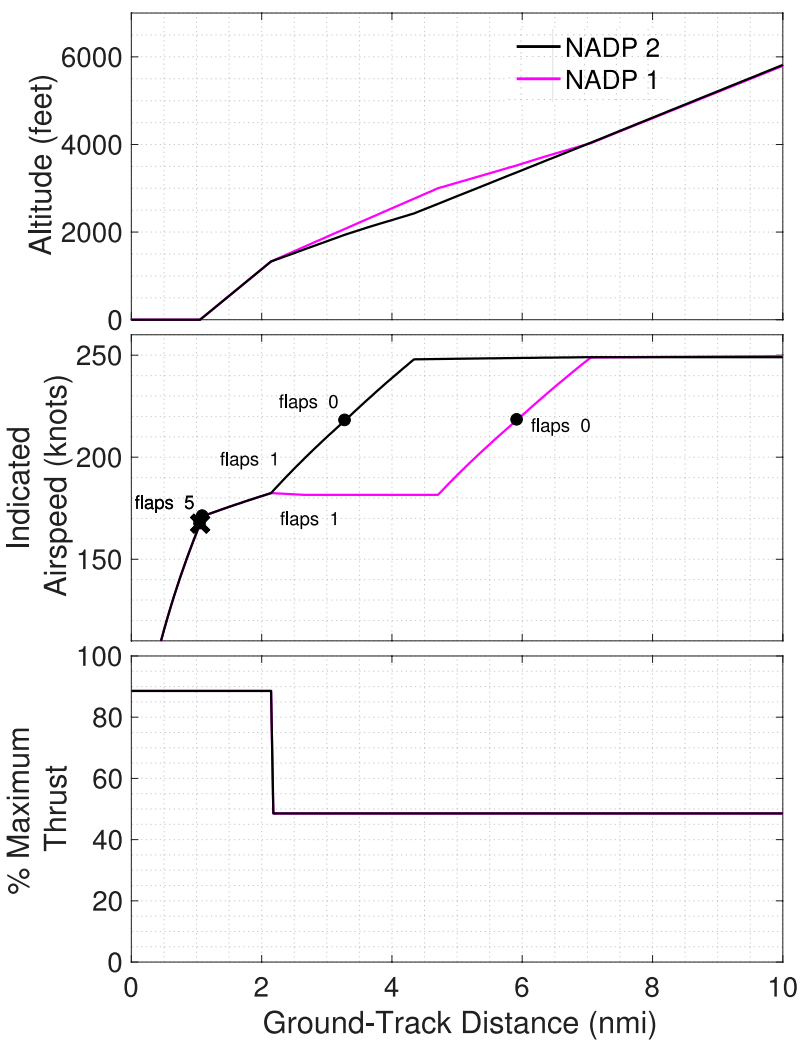
- ***Airport Noise Mitigation and Safety Study***
  "Not later than 1 year after enactment, the FAA shall initiate a study to review and evaluate existing studies and analyses of the relationship between jet aircraft approach and takeoff speeds and corresponding noise impacts on communities surrounding airports"
- **Contents:**
  I. Intro
  II. Impact of Speed on Aircraft Source Noise
  III. Modeling Framework
  IV. Effect of Aircraft Speed on Departure
    - Changing Height of the Start of Acceleration and Flap Retraction
    - Reduced Speed Climb
  V. Effect of Aircraft Speed on Arrival
    - Changing Start of Deceleration
  VI. Conclusion

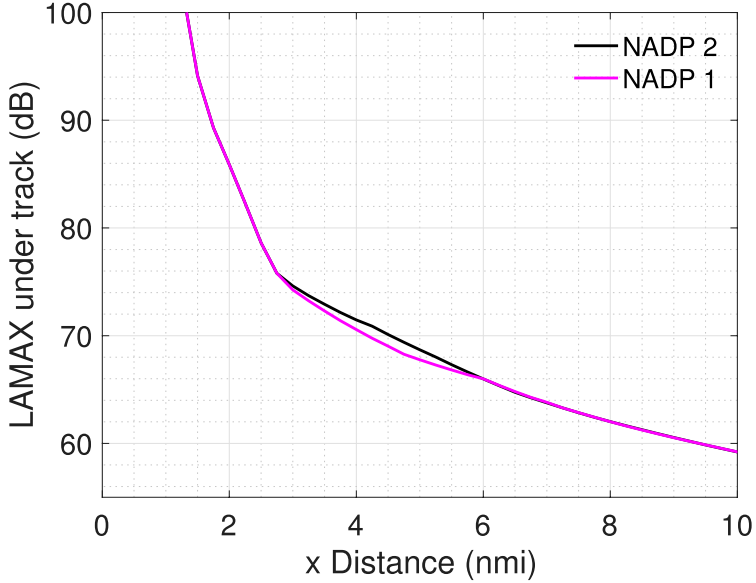
Noise Abatement Departure Procedures

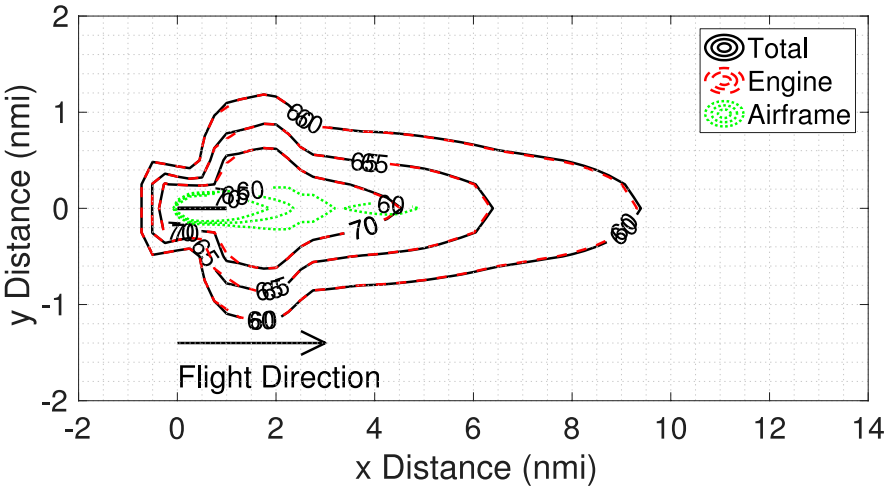


Graphics adopted from ACRP 02-12 Report 86

- *ICAO PANS-OPS Vol. 1* includes definitions for NADP-1 and NADP-2
  - Operators have considerable latitude to develop their own profile designs within these general parameters
- Differ primarily in where the start of acceleration and flap retraction occurs
- NADP-1 generally used internationally, while NADP-2 is the primary procedure in the US



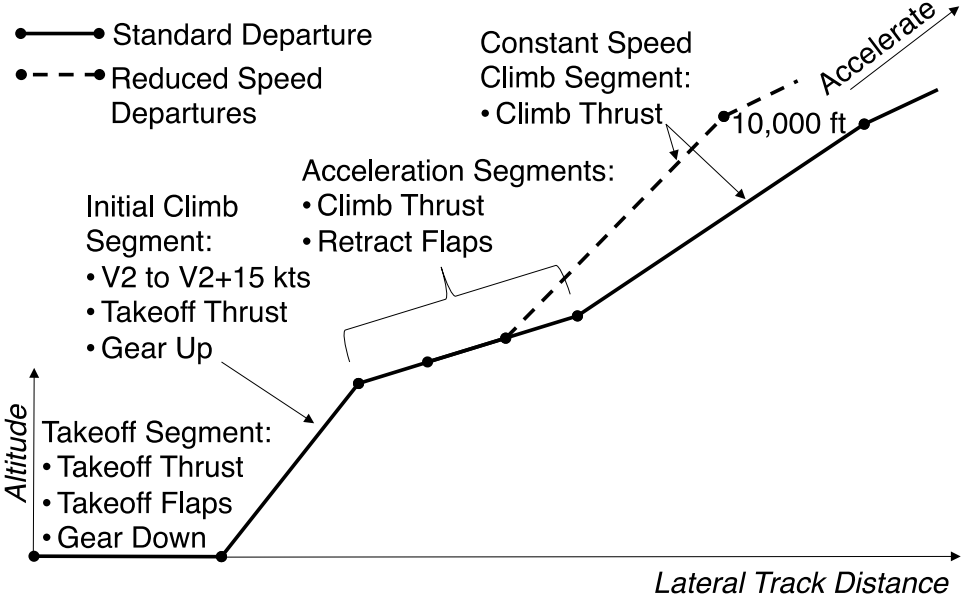


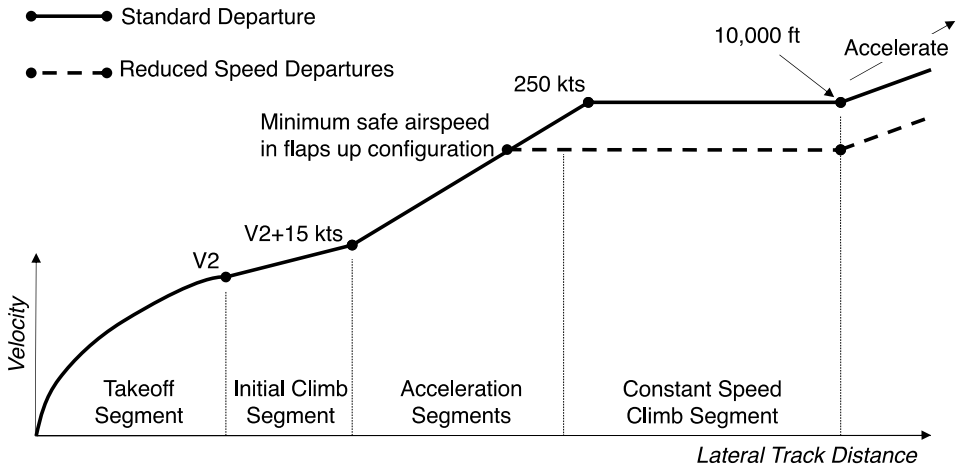


$L_{A,MAX}$ (dB) contours for a typical Boeing 737-800 departure

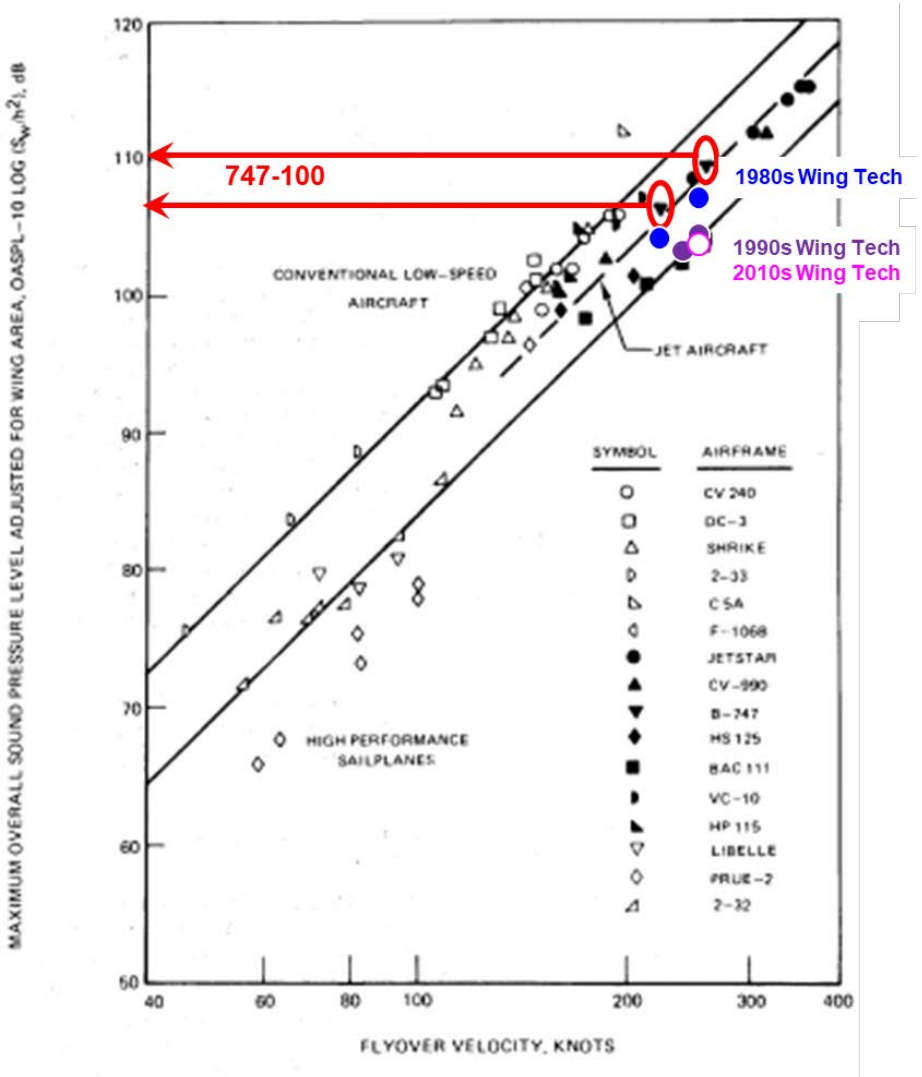
- Aircraft on departure operate at moderate to high thrust levels, and thus engine noise is generally sufficiently loud that reductions in noise generated by the airframe through speed and configuration management would not be noticeable

Reduced Speed Climb





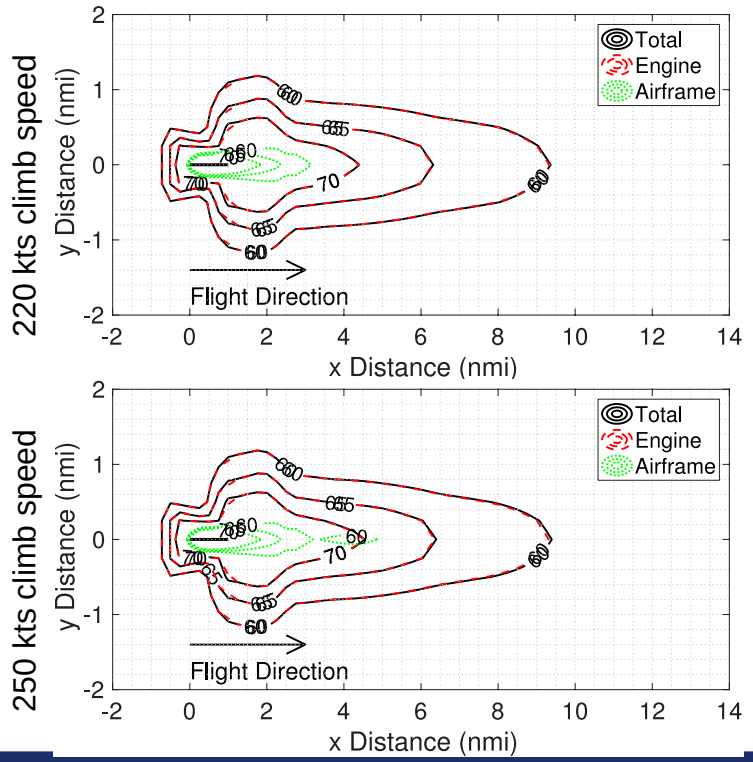
- Goal is to reduce highly speed-dependent clean airframe (flaps, slats, and gear retracted) noise during the climb segment after initial thrust reduction



MAXIMUM OVERALL SOUND PRESSURE LEVEL FOR CLEAN AIRFRAMES, NORMALIZED WITH RESPECT TO PRODUCT OF WING SPAN AND WING TRAILING EDGE BOUNDARY LAYER THICKNESS

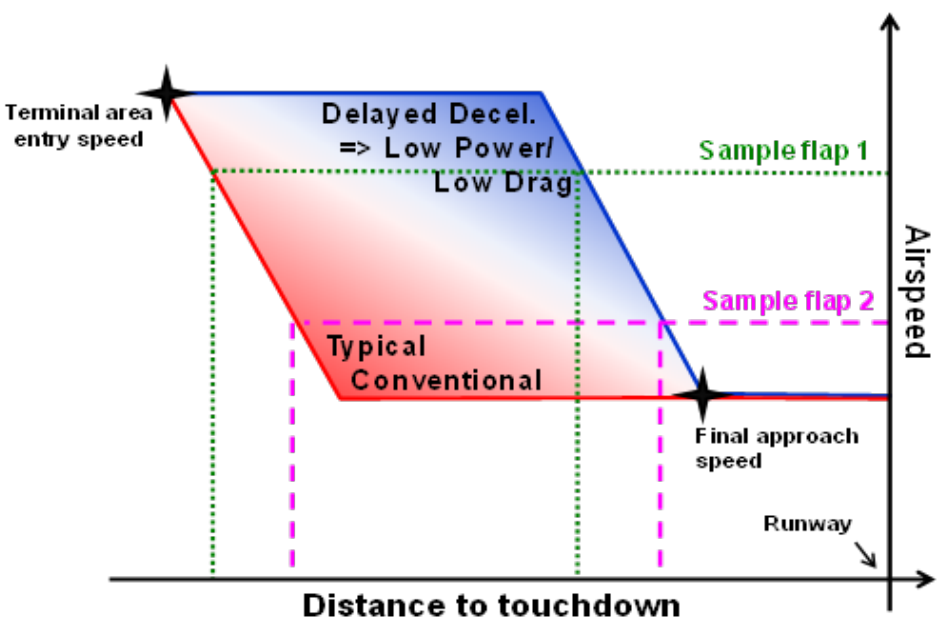
Christenson, Barker, Nesbitt; "Commercial Aircraft Clean Wing Airframe Noise Levels – Comparison with NASA ANOPP Fink Model"; The Boeing Company; Boeing Document ROI 19-00375BCA; 12/16/2019.

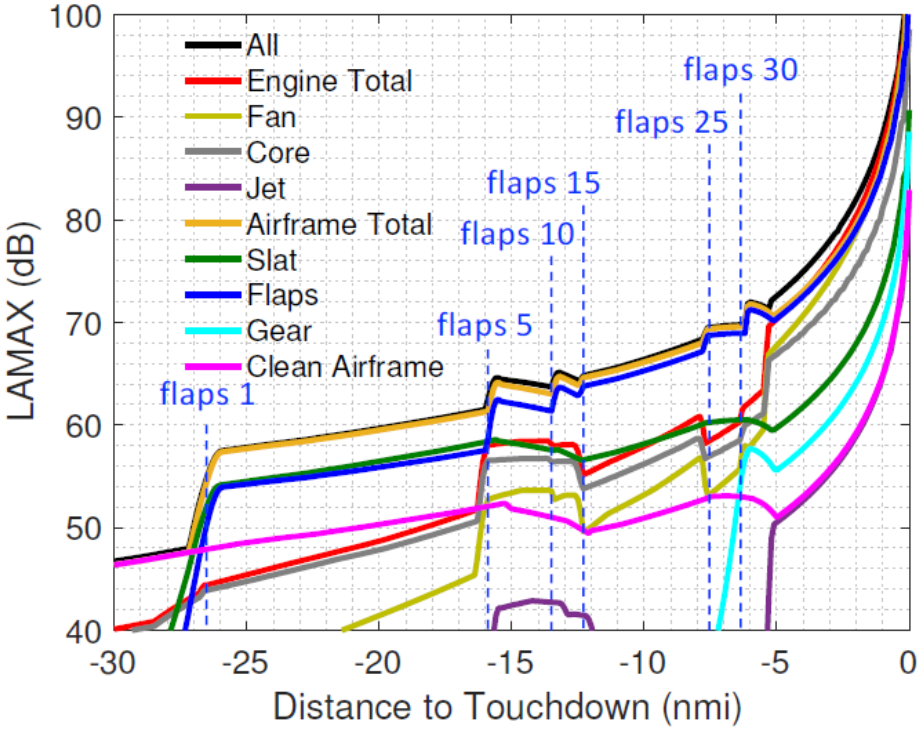
- Clean airframe noise sensitive to "Wing Cleanliness factor" in ANOPP (by factor of ~ 8 dB)
- Data from NASA and Boeing indicates that modern airplanes are closer to "aerodynamically clean" assumption



Changing Start of Deceleration on Arrival (Delayed Deceleration Approach)

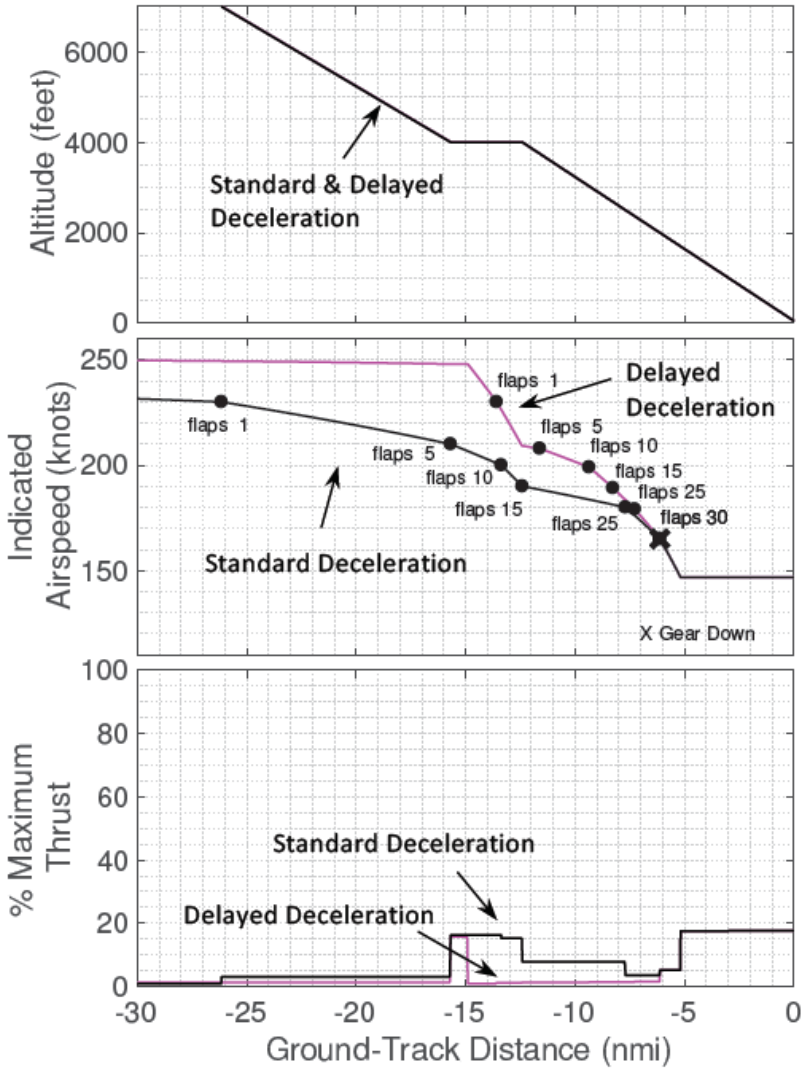
- Reduce noise by delaying extension of flaps
- Must decelerate early enough to ensure stable approach criteria

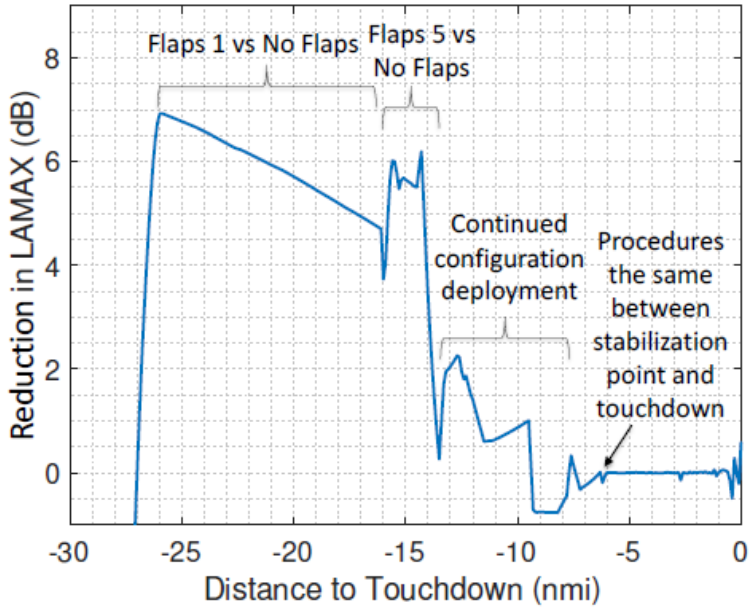




Under Flight Track Noise by Component, Representative Narrow Body Aircraft Approaches with 4,000 ft Level-Off

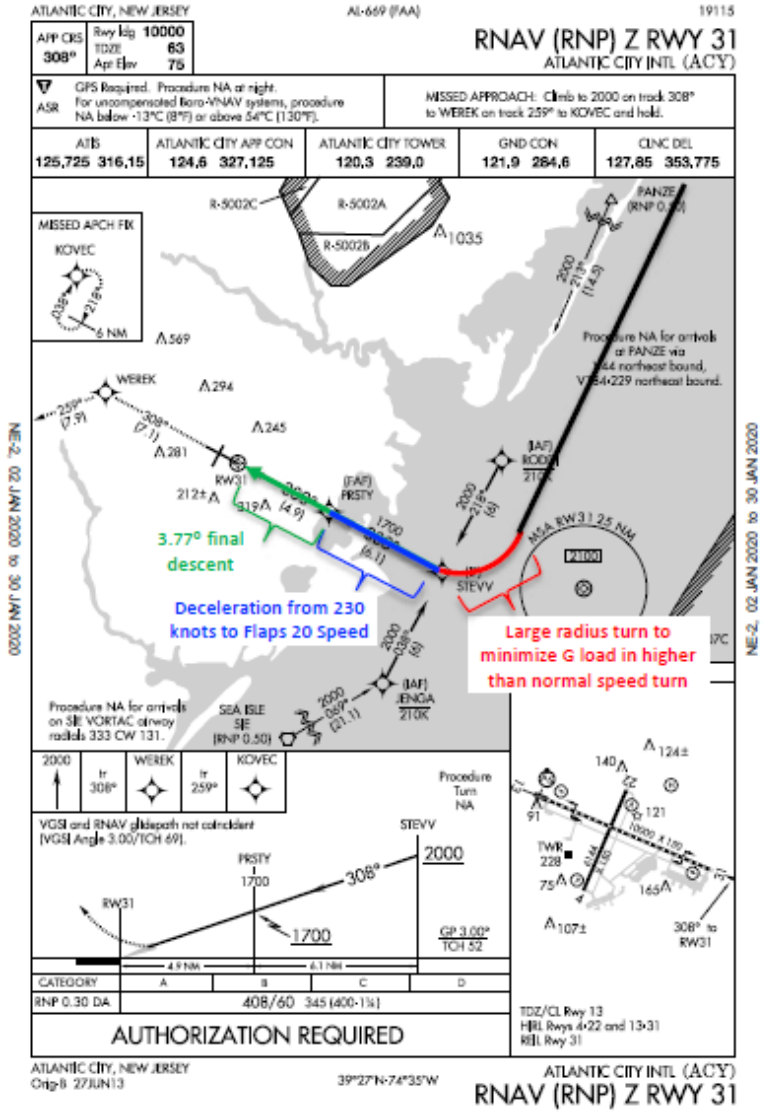
DDA Noise Assessment

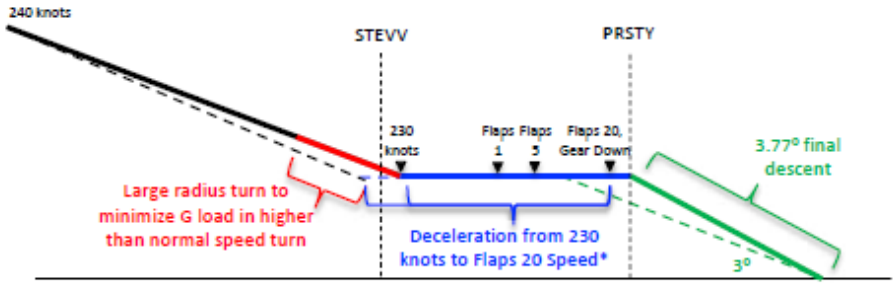




- Engine thrust on approach is relatively low → airframe noise components more easily heard
- Validation and implementation challenges remain

ecoDemonstrator Target of Opportunity





*Length of deceleration segment dependent on aircraft weight, wind, and weather conditions

Test Results and Observations

- **Successfully executed procedure**
- **Pilots reported that procedure worked really well; airplane performed as it did in simulator prep**
- **Pilots will need procedures or guidance to manage deceleration considering weight, winds, and air density to ensure stable approach**
  - Boeing developed a simple app for this test that provided notifications on when to deploy flaps
- **3.77° glideslope did not require speed brakes—engines spooled up enough to pull back on throttle for control**

DDA Challenges

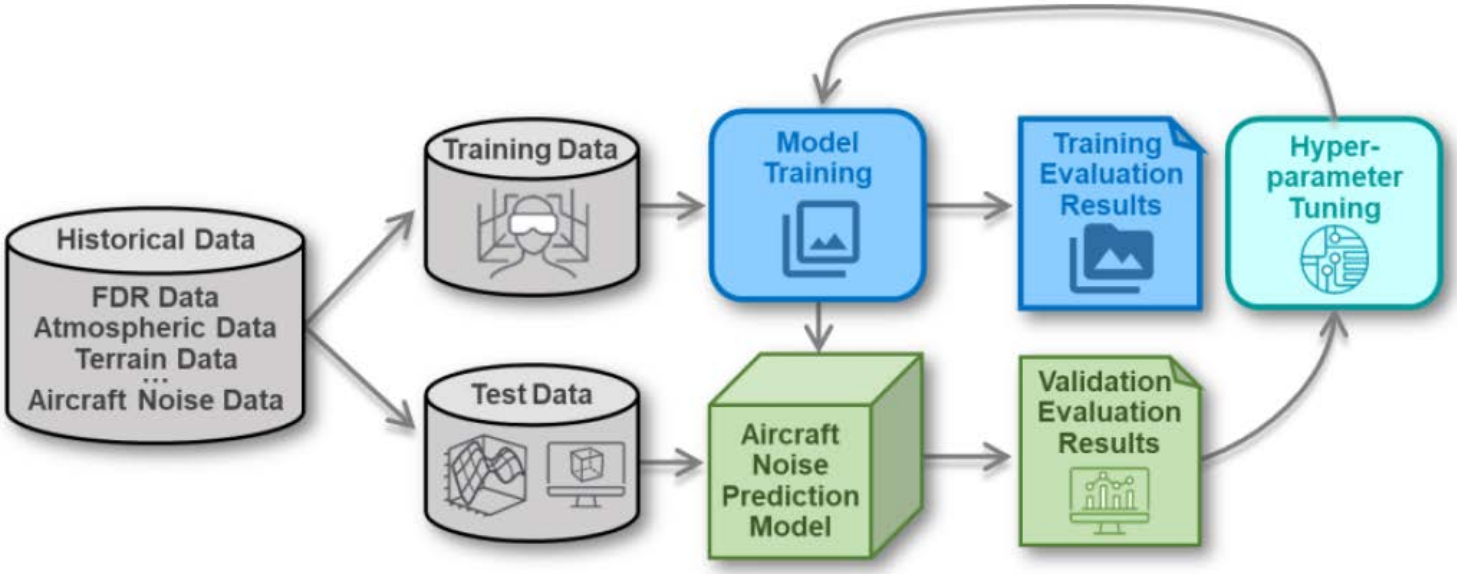
- **Operational validation of noise benefit**
  - Future ecoD opportunities
  - Find a motivated airline partner
  - ASCENT Project 44 collaboration with Boeing

- **Pilot guidance**
  - Continued discussion with pilots
  - DLR Low Noise Augmentation System, A350 Flight Management System

- **Different deceleration rates for different aircraft creates ATM challenge in sequencing aircraft**
  - Continued discussion with FAA Office of NextGen, Air Traffic Organization, and Flight Standards Service

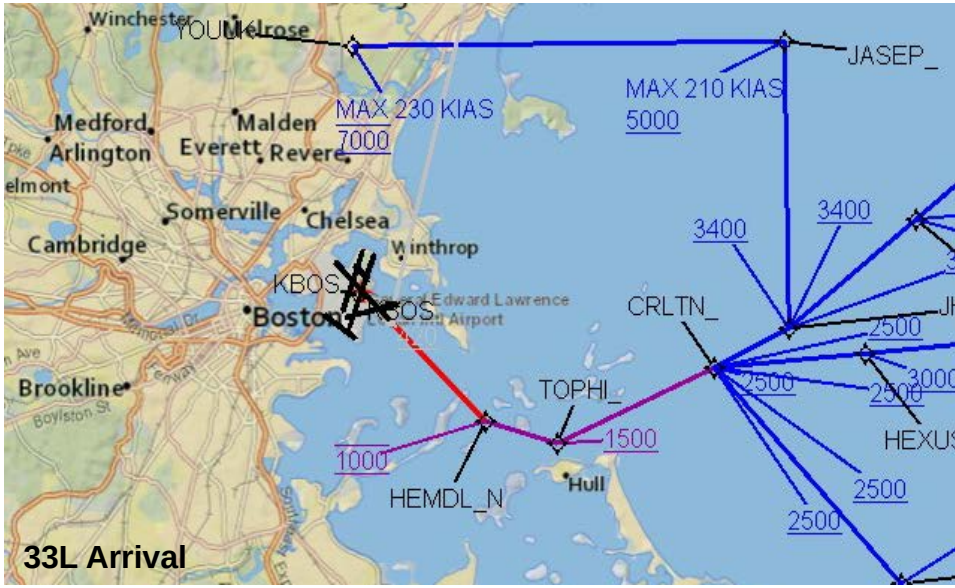
ASCENT Project 44: Noise Data Mining

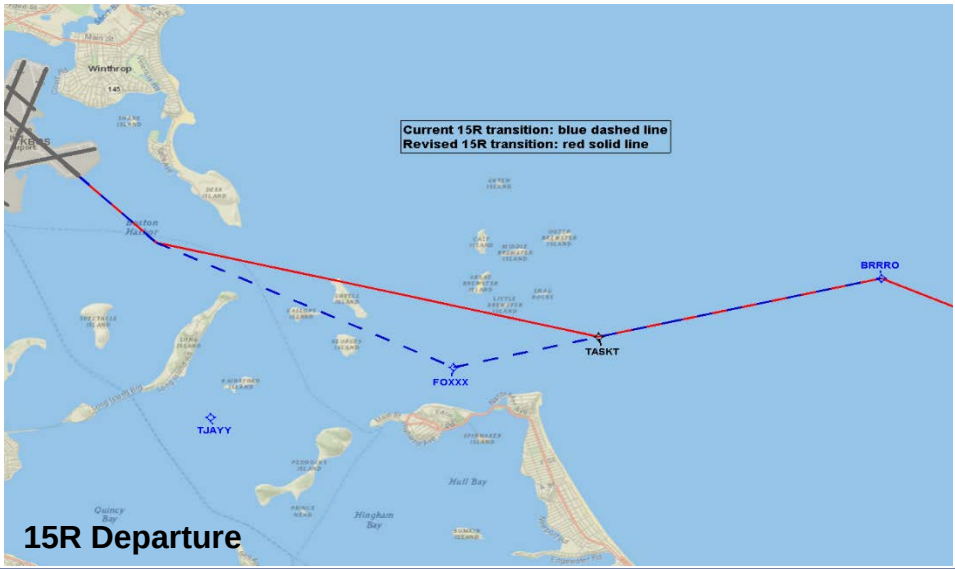
- **Funding awarded to MIT to work with Boeing to correlate aircraft state data with noise measurement data**
- **Apply Machine Learning to develop data-driven noise predictor and identify low-noise behaviors**
- **Grant currently being processed**



Massport MOU Update

- **Proposed RWY 33L arrival required a waiver, which was denied**
- **RWY 15R departure requires a waiver due to FAA criteria changes**
- **FAA has redesigned both concepts and presented to Massport / MCAC for acceptance**
- **Block 2 on hold until Block 1 resolved**





Summary

- **Despite considerable progress in reducing aircraft source noise and community noise exposure, aviation noise remains a concern in many areas**
- **FAA is exploring operational opportunities to reduce the noise from the current fleet**
- **Developing tools to better assess benefits of advanced operational procedures**
- **Seeking opportunities to operationally validate and measure concepts with potential to reduce noise**