FAA Research on Aviation Noise

To: 32nd Annual Aviation Noise and Emissions Symposium
By: Dr. James I. Hileman
Chief Scientific and Technical Advisor for Environment and Energy
Federal Aviation Administration
Office of Environment and Energy
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Outline

• Background on Community Noise
• Overview of FAA Aircraft Noise Efforts
• Research on Aircraft Noise Impacts
• Outreach
• Efforts to Mitigate Aircraft Noise
• Noise Modeling
• Summary
Community Noise from Aircraft

Aircraft Noise

- Engine Fan & Jet Exhaust
- Undercarriage
- High lift system

All noise sources contribute to acoustic signature – both at takeoff and during landing

Landing Takeoff Cycle

- Approach: 2,000 m from threshold
- Sideline: 450 m from runway edge
- Flyover: 6,500 m from brakes off

Community Exposure

Community exposure set by aircraft types and operational tempo over day and night
Commercial Aircraft Noise Evolution

Cumulative Noise Level Relative to Stage 3 (EPNdb)

Year of Certification

STAGE 2

B737-200
B727-200
DC-9-10
DC8-55F
B707-300
B727-100

STAGE 3

B747-100
B747-200
747-100F
MD10-10F
DC9-14
A300B2/B4F
B767-200
B737-300
MD-82
A310-300
B757-300
A320-200
B747-300
MD83
A300F
B747-400
MD87
A320-300
B737-800
MD11
B737-900
B737-700

STAGE 4

B777-200
A340-300
MD717-200
A300-300
MD90-30
A340-600
B747-8
A380-800
B787-9RR
A320CFM
B787-9GE
A320PW
A350-941
Noise Reduction through Technology

- Noise improvements have come with fuel efficiency gains
- Increased engine bypass ratio

- Simplified high lift systems

Images from airliners.net
A factor of 20 decrease in community noise exposure has been achieved despite a four-fold increase in passenger enplanements, but it has also been accompanied by increased community concerns.
Equivalent Operations for DNL = 65

**DNL Metric**
- DNL metric provides cumulative noise exposure to many individual noise events
- Can reach given DNL with single loud noise event or many quieter noise events

**Aircraft Noise over Time**
- Aircraft noise from 1970s is different than aircraft noise today
- Aircraft from 1970s produced the same acoustic energy as 10 to 30 aircraft operations today

**Equivalent DNL**
- A few, but relatively loud, events in 1970s would result in DNL 65 dB
- Many, relatively quiet events today would also result in DNL 65 dB
- However, noise experience would be very different
Precision Navigation

- Precision navigation is being implemented to increase the safety and efficiency of the NAS.
- It also leads to a reduction in the overall number of people exposed to noise from aircraft operations.
- However, the implementation of precision aircraft navigation over the last few years has contributed to the increased airport community concerns regarding noise.

Image Source: Massport
Today’s Situation

Old Perspective:
"If you don't like airport noise, then don't live near an airport."
- Anonymous blogger in response to Washington Post editorial on aircraft noise

New Perspective:
People from well outside the DNL 65 contour are expressing concerns today.

Graphic compiled by J. Hansman et al. (MIT) using complaint data from Massport complaint system and noise contours from the Boston-Logan International Airport 2015 Environmental Data Report (http://www.massport.com/media/2274/2015_edr_compiled_final_version.pdf)
Addressing the Aircraft Noise Challenge

• **Understanding Impact of Noise**
  – Improving modeling capabilities
  – Examining relationship between noise and annoyance, sleep, cardiovascular health and children’s learning.
  – Evaluating current aircraft, helicopters, emerging civil supersonic aircraft and commercial space vehicles, and drones.

• **Outreach**
  – Increase public understanding
  – Community engagement

• **Mitigation**
  – Land use planning and related measures
  – Vehicle operations
  – Airframe and engine technology
  – Aircraft architecture
ICAO CAEP Environmental Report
AVIATION NOISE IMPACTS: STATE OF THE SCIENCE

Contents:
1. Introduction
2. Community Annoyance
3. Children’s Learning
4. Sleep Disturbance
5. Health Impacts
6. Civilian Supersonic Aircraft: A Future Source of Aviation Noise
7. Conclusions

Available at:
http://www.icao.int/environmental-protection/Pages/env2016.aspx
FAA Aircraft Noise Impact Research (1 of 2)

Community Annoyance (HMMH / Westat)

• **Objective:** Develop an updated and nationally representative dose-response curve of civil aircraft noise exposure and community annoyance. Query individuals experiencing a wide range of noise exposure near airports with variations in aircraft operations using an identical methodology.

• **Status and Timeline:** Survey results and a draft report are in process of being reviewed by FAA in coordination with Department of Transportation and other federal agencies. Once final, report will be made available to the public.

Children’s Learning (ACRP 02-26 and 02-47)

• **Objective:** Understand potential effects of aviation noise exposure on learning in children through test scores, classroom observations, and teacher questionnaires.

• **Results:** ACRP 02-26 study showed a small but statistically significant correlation exists between noise exposure and student test scores. ACRP 02-47 teacher survey suggests that even moderate levels of aircraft noise exposure may impact children’s learning experiences; however, there were no observed aircraft noise related distractions on any day of the study period.

• **Status and Timeline:** ACRP Studies are complete. Exploring next steps.

More Information:
- ACRP 02-26: Assessing Aircraft Noise Conditions Affecting Student Learning
- ACRP 02-47: Assessing Aircraft Noise Conditions Affecting Student Achievement—Case Studies
Sleep Disturbance (ASCENT Project 17)

- **Objective:** Develop and use an inexpensive, scientifically sound methodology to obtain objective measures of sleep disturbance from aircraft noise. Use methodology to develop relationship between aircraft noise exposure and sleep disturbance that is representative of airport communities across the U.S.

- **Status and Timeline:** Conducted field studies to test different equipment viability in PHL. Validated in another U.S. airport. Recently began planning national sleep study that will require 4 to 5 years of effort.

Health Impacts (PARTNER Project 44 and ASCENT Project 3)

- **Objective:** Determine what, if any, correlation exists between cardiovascular disease and aviation noise. Using noise modeling with epidemiological studies.

- **Status and Timeline:** Have expanded upon initial work PARTNER that used Medicare database to look at other health cohort databases. Leveraging work being funded by National Institutes of Health. Initial results with new cohorts coming out this year. Expect work to continue for a few more years.

More Information:
- PARTNER Project 44: http://partner.mit.edu/projects/aviation-related-noise-effects-elderly
- ASCNET Project 003: https://ascent.aero/project/noise-impact-health-research/
- ASCENT Project 017: https://ascent.aero/project/noise-exposure-response-sleep-disturbance/
Noise Outreach

Community engagement
• 2016 was a transformational year for the FAA’s community involvement strategy and practices
• Comprehensive and strategic approach to community involvement efforts was central to this transformation
• Agency-wide guidance materials were developed and staff are being trained on best practices for engagement.

Noise Complaint Initiative
• More efficiently and effectively respond to and address noise complaints in a clear, consistent and repeatable manner that is responsive to public and applies best use of FAA resources.
• Internal testing completed and implementing lessons learned. Working on internal and external roll-out.

Increase public understanding
• Developing new FAA website on noise to help inform public with background information, links, and relevant information as it becomes available
• Have been supporting NoiseQuest website through PARTNER and ASCENT

More Information on Community Engagement:
• https://www.faa.gov/nextgen/nextgen_near_you/community_involvement/
Noise Quest Website
• http://www.noisequest.psu.edu/
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

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**

More Information:
ASCENT Project 023 website:
https://ascent.aero/project/analytical-approach-for-quantifying-noise-from-advanced-operational-procedures/
Multiple Efforts Underway to Develop Noise-Mitigating Operational Procedures

ASCENT-23
Developed analytical framework for assessing operational procedures

AEDT
Development efforts underway to improve modeling capabilities

知识 & 工具/选项

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

PBN Operations at Low Altitude (MITRE)

Application of ELSO and Open SIDs (MITRE)

Knowledge & Tools/Options to Mitigate Noise

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

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

- Exploring Ideas with OEMs

- Research kicks off in FY2018

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/
Modeling Noise

Aviation Environmental Design Tool (AEDT)

- Computes noise, fuel burn and emissions simultaneously
- Can analyze airport, regional, national, and global scales
- Required for all regulatory actions

AEDT Development Plan

- Current version of tool, AEDT2d
- Developing AEDT3a with release in 2018
  - Seeking to improve abilities at lower DNL
  - Improving takeoff weight and thrust modeling
  - Improving aircraft performance module
- Laying ground work to incorporate airframe noise more explicitly in AEDT4 with a post 2020 release

For more information on AEDT or to download it, please visit: https://aedt.faa.gov/
Closing Observations

• Despite considerable reductions, noise remains a concern in many areas.
• New users of NAS present additional challenges (Unmanned Aerial Systems, Commercial Space Vehicles, Civil Supersonic Aircraft).
• Have developed a comprehensive approach to address aircraft noise.
• Improving outreach via Community Involvement Manuals, Noise Complaint Initiative, websites.
• Executing research program to better understand noise impacts.
• Advancing our modeling tools to improve our ability to model aircraft noise.
• Examining potential means to reduce noise from the current fleet through operational procedure concepts.
• Accelerating technology advancements to achieve aircraft noise reduction (CLEEN Program).
Dr. Jim Hileman
Chief Scientific and Technical Advisor for Environment and Energy
Federal Aviation Administration
Office of Environment and Energy
Email: james.hileman@faa.gov