AEE Research Update

Helicopters/UAS/UAM

Presented to:	REDAC
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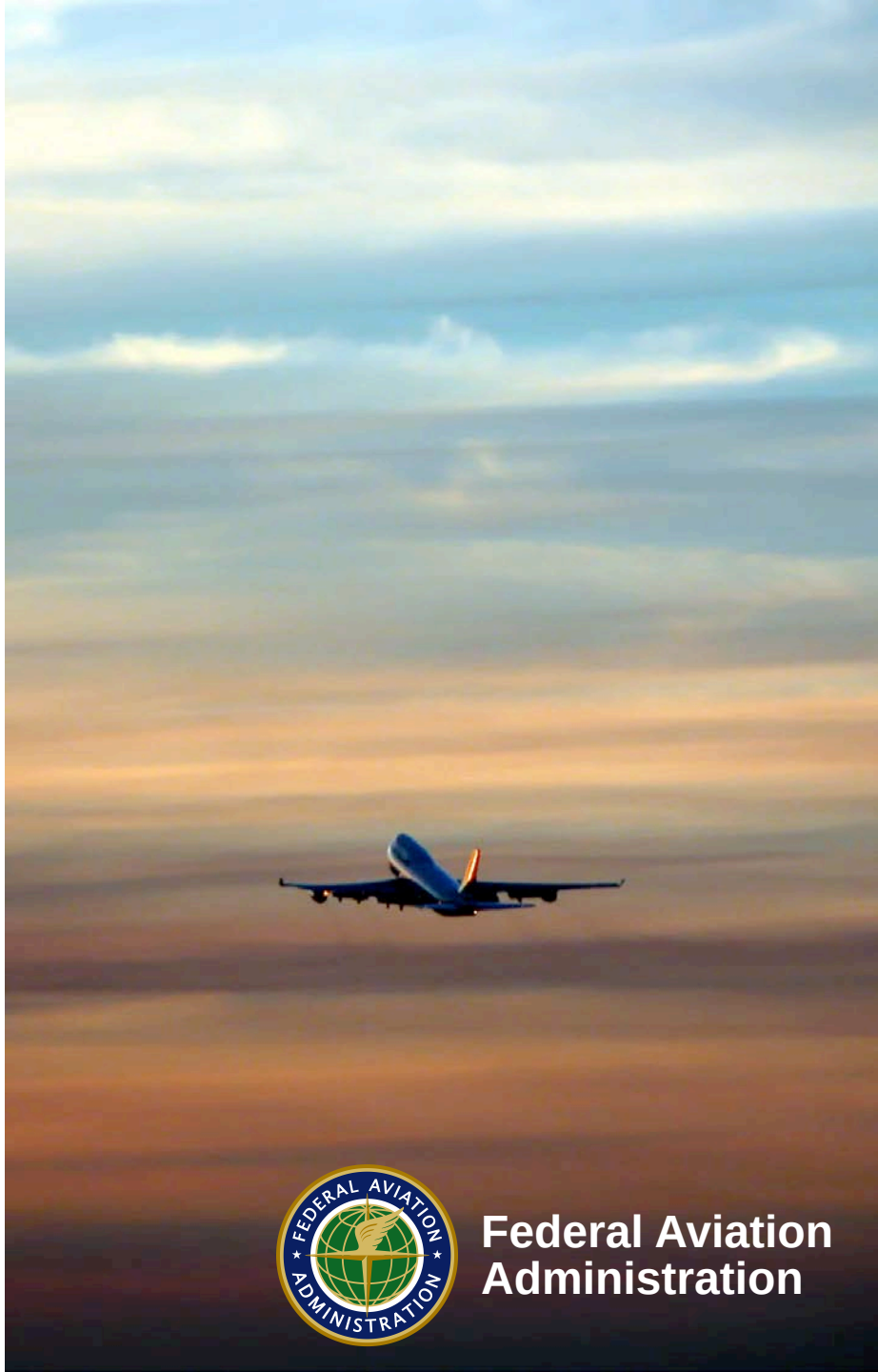


Helicopter

AREAS OF RESEARCH

MODELING:

ASCENT Project 38, Pennsylvania State University (PSU) in conjunction with Continuum Dynamics has developed a physics based model CHARM/HELOSIM/PSU WOP-WOP (a.k.a PSU-WOPWOP)

TESTING AND VALIDATION:

NASA/FAA noise testing being conduced to develop noise abatement procedures and provide test data in 2017 to validate and refine model. A test in 2019 was conducted to obtain data on heavier helicopters

FLY NEIGHBORLY PROGRAM:

FAA/Volpe working to develop Noise Abatement Procedures that can be tailored to individual heliports by the operators and promote those procedures to helicopter operators and pilots

MODELING

- CHARM/HELOSIM/PSU-WOPWOP: A physics based model that can predict steady state and maneuvering rotorcraft operations in order to develop noise abatement procedures

- New Design Prediction Capability: Predict rotorcraft noise for existing and new designs

- Starting in 2020, the work will include model development of Urban Air Mobility (UAM) and Unmanned Air Systems (UAS)

TESTING AND VALIDATION

NASA/FAA 2017 and 2019 Noise Tests

- Ten aircraft 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
- Testing was conducted in September 2017 at Eglin Air Force Base and Amadee Army Airfield and Coyle Field, NJ in 2019

HELICOPTERS TESTED

Sikorsky S-76D

Bell 407

AW139

Bell 206-LIII

AS-350

Dauphin AS-365

R-66

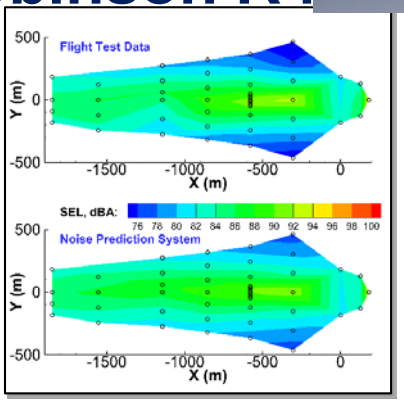
EC-130

Bell 205 “Huey”

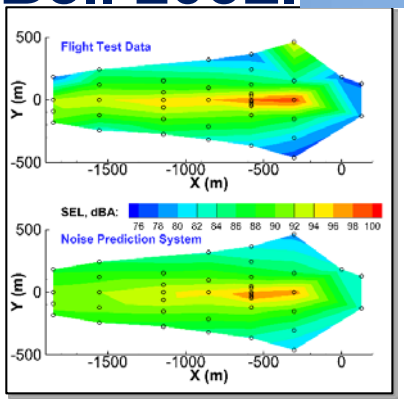
R-44

MODEL VALIDATION 6 DEG APROACH 80 KT

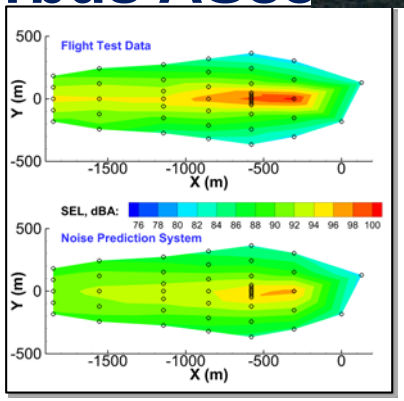
•Robinson R4



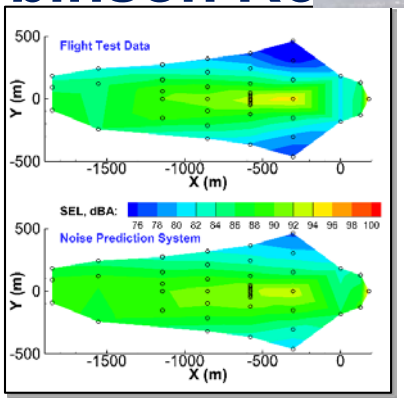
•Bell 206LI



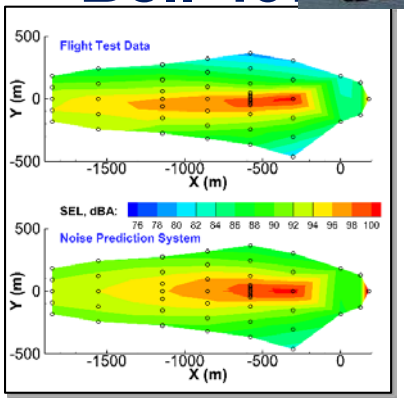
Airbus AS35



•Robinson R6



•Bell 407



•Key Takeaways

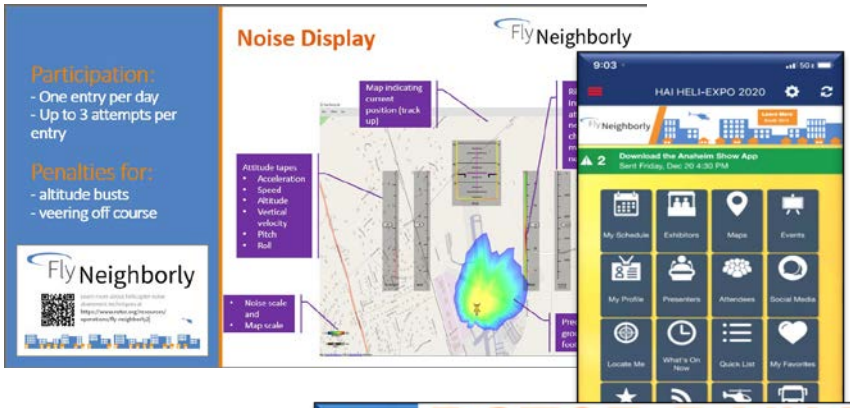
- BVI noise important part of descent condition
  - BVI noise more intense for Bell 407
- Agreement within 2-4 SELdBA (often <2)
- Noise prediction system useful for noise abatement procedure development

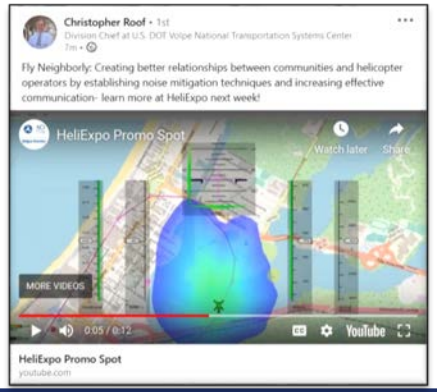
FUTURE RESEARCH

- Add Broadband Noise and Engine Noise to PSU WOP-WOP
- Prediction capability for ducted rotors and tiltrotor vehicles
- Develop advanced noise abatement procedures tailored to individual helicopters
- Complete analysis of NASA/FAA 2019 noise test
- Planning for possible future helicopter testing
- Expand prediction capabilities to Unmanned Air Mobility (UAM) and Unmanned Air Systems (UAS) (Project 49 – see next section)

FLY NEIGHBORLY

- Big presence at Heli-Expo 2020
  - NASA Fly Neighborly Simulator Contest
- Marketing for Fly Neighborly
  - ROTOR Daily articles
  - 12-second promo video
  - Heli-Expo App advertising
  - Social Media posting by Helicopter Association International (HAI), DOT, others





FLY NEIGHBORLY

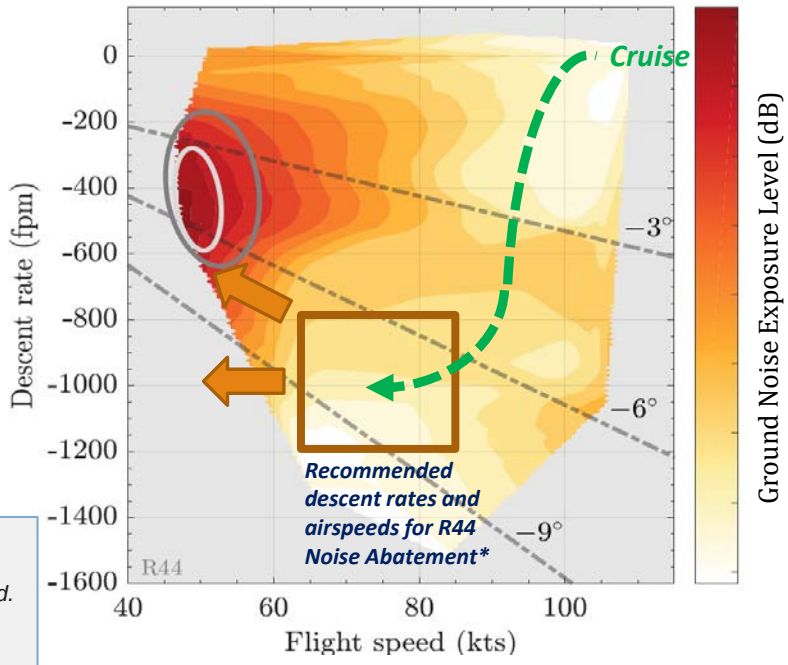
Helicopter Association International

Fly Neighborly
HELICOPTER PILOT TRAINING PROGRAM

Plan your approach path:

- BVI noise happens during specific descent rate and flight speed combinations as illustrated →
- Establish a descent rate at a steady speed that avoids BVI
- Decelerate as quickly and closely to landing as practical and safe [⟵]
- Deceleration makes the effective flight path angle steeper (1 kt/sec = 3° steeper)

Operational Noise: Robinson R44



Fly Neighborly procedures / recommendations should be executed in the safest manner possible and followed only to the extent that safety is not compromised.

Take the Fly Neighborly training: https://go.usa.gov/xQPCW

Avoid descent conditions with high Blade Vortex Interaction (BVI) noise (white/gray ovals)

*** Data & procedures derived from NASA/FAA flight tests and analyses.** References: Watts, M.E., Greenwood, E., Smith, C.D., and Stephenson, J.H., "Noise Abatement Flight Test Data Report", NASA TM-2019-220264. Page, J.A., Rapoza, A.S., Jacobs, E.W. "In Situ Development and Application of Fly Neighborly Noise Abatement Procedures for Helicopters", VFS Forum 75, 2019. Pascioni, *et al*., "Medium-Sized Helicopter Noise Abatement Flight Test", VFS Forum 76 publication pending 2020.

FLY NEIGHBORLY

- Auditory Techniques
  - New Training Module for Fly Neighborly Completed
  - HAI Approved for inclusion on HAI Online Academy
  - HAI Coordinating submission to FAA WINGS program

Auditory techniques *provide a process for identifying new/improved noise abatement flight procedures* ***by listening*** *to aircraft operations. Keys are knowing* ***where*** *to listen,* ***what*** *to listen for, and how best to* ***modify existing flight operations****. They may be utilized when current Fly Neighborly guidance is non-existent or proves inadequate.*

  - FAA funded – training developed by Volpe/EBDEA Acoustics LLC
  - Content based on 2017 & 2019 Joint NASA-FAA Helicopter Flight Tests at Eglin/Amedee and Coyle FIeld

UAS/UAM

UAM/UAS Research on Noise

- **Questions we aim to answer**
- **UAS/UAM Noise Certification**
- **ASCENT Project 49**
- **UAS Integration Pilot Program (IPP)**
- **Other UAS Measurements**

UAS Noise Questions

- Which vehicles require certification?
- What procedures should be used for certification? (i.e. operating modes, altitude and speed, microphone and placement, etc.)
- What noise limits and metrics are appropriate for certification?
- How should FAA approach the noise analysis for Environmental Review?
- What is needed to meet requirements of other environmental laws (e.g. Tribal consultation, Historic Property)
- How should we integrate UAS/UAM into AEDT?

Noise Certification

Noise Certification is the primary means of controlling aircraft noise at the source

- ICAO Annex 16 is recognized worldwide as the primary noise certification standard
- 14 CFR Part 36 is U.S. equivalent
- FAA is the Certificating Authority in the U.S.
- Office of Environment & Energy (AEE) is responsible for aircraft noise certification regulations, with the certification offices implementing the certification

UAS Noise Certification

- Today, all Manned or UAS/UAM aircraft are subject to noise requirements of 14 CFR Part 36 regardless of Maximum Takeoff Weight
- Legal precedence is well established that UAS/UAM are aircraft
- They are subject to the noise certification and testing requirements of 14 CFR Part 36
- Noise certification will initially be based on best-fit and adapting requirements of existing categories
- Research is needed to fully understand the differences in physical configuration, propulsion, operational characteristics and public response between conventional and unconventional aircraft to determine how current noise certification procedures may need to be supplemented for UAS/UAM

Upcoming ASCENT Projects

Research Projects Expected to Start in September 2020

Project 9: Geospatially Driven Noise Estimation Module (Georgia Tech)

- Develop a novel geospatially driven noise estimation module to support computation of noise resulting from the operation of Unmanned Aircraft Systems (UAS) and other upcoming vehicle concepts.

Project 61: Noise Certification Streamlining (Georgia Tech)

- Examine the process of noise certification and develop a streamlined approach that is flexible enough for current, emerging, and future air vehicles.

UAM/eVTOL NOISE MODELING
ASCENT Project 49 (Penn State)

- PSU Current Capability -CHARM/HELOSIM/PSU-WOPWOP: A physics based model that can predict noise for steady state and maneuvering rotorcraft operations in order to develop noise abatement procedures
- Starting in 2020, the work will include model development of Urban Air Mobility (UAM) and Unmanned Aircraft Systems (UAS) – Electric Vertical Takeoff and Landing (eVTOL) aircraft
- New Capability – Modeling multiple lifting rotors and propellers, both ducted and unducted, and their interaction with each other and the airframe in order to predict their acoustic signature
- Application – Predict noise of OEM designs to support noise certification development. Develop noise abatement procedures for novel new vehicles

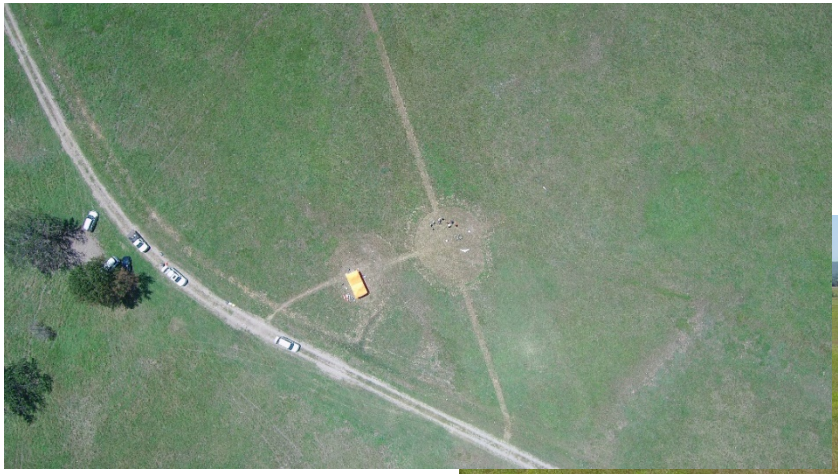
UAS Integration Pilot Program (IPP)

- **Purpose of the IPP Noise Research**
  - Comply with MOA requirements
  - Populate a UAS noise database for use in noise modeling and research
  - Assist in disclosing impacts to comply with NEPA
  - Improve understanding of noise from typical operations of these aircraft (e.g. lower than conventional aircraft);
  - Evaluate UAS noise to determine:
    - possible methods for reducing impact on communities
    - possible noise certification metrics, specifications, and requirements

FAA's goals for IPP Noise Research

- Collect data to help inform FAA policymakers on appropriateness of current certification methods and possibly support development of new certification methods or exempt some UAS from certification requirements
  - Collect data to support possible new noise metrics
    - Record high resolution audio (up to 20kHz) to allow computation and analyses of alternative metrics
  - Collect data representative of typical flight procedures when such procedures are different from those specified for certification
    - Capture realistic operations as communities may experience them
    - Capture operations exhibiting unique noise characteristics
- This data collection supports the regulation and policy objectives of H.R.302, section 351 (the IPP authority in the 2018 FAA reauthorization act)

IPP Noise Research



Ongoing Discussions

- NASA Acoustics Technical Working Group
- NASA UAM Noise Working Group
- INCE UAS Noise Workshops
- Quiet Drones Symposium
- SAE A-21 Technical Committee
- TRB Annual Meetings
- Industry-led initiatives
- ICAO CAEP
- Likely others…