The ((Quiet)) Electric VTOL Revolution

3rd Annual Panel at Heli-Expo 2020

January 29, 2020
Anaheim, California

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Outline

• Fly Neighborly / Environmental Working Group
• Community Noise Modeling for eVTOL
• Challenges
FN/E Objective: facilitate the collection and dissemination of information, and to develop appropriate material, related to the HAI voluntary Fly Neighborly noise reduction program. The committee will consider all types of civil, military, governmental helicopter operations, HAI members and all other individuals or other organizations that would benefit, in a positive nature, from such information.
HeliExpo 2020  #flyneighborly

- NASA Fly Neighborly Contest
- Daily Amazon Gift Card Winner
- Fly Neighborly Training
  - FAA WINGS (credit)
  - HAI Online Academy
- RSC Fly Neighborly Classes
Community Noise: Integrated & Simulation Models

**Integrated Noise Models:**
- **1989 - 1994** – Heliport Noise Model *(HNM)* V1.1 – V2.2
  - Integrated noise formulation, used for heliport assessment, Conventional Helicopters
  - Omnidirectional noise source. Noise-Power-Distance (NPD) from certification data
- **1995** – Integrated Noise Model *(INM)* V1-V7
  - V 6.0c (2001) Incorporated limited helicopter capability with the fixed wing model
  - V 7.0 (2007) Fully incorporated HNM V2.2 & extended to include limited helicopter directivity (R/C/L) and hover directivity
- **2010 - 2020** - Aviation Environmental Design Toolkit *(AEDT)* V1 – V3b
  - Integrated Model, Includes Emissions / AQ, Database driven, georeferenced front end GUI

**Simulation Noise Models:**
- **1995** – ROTONET Rotorcraft System Noise Prediction System, element of ANOPP
- **1997 - 2006** – Rotorcraft Nose Model *(RNM)* V1 - V7
  - Simulation model
  - Helicopters and Tiltrotors
  - Noise spheres for source noise emission characteristics (3D, 1/3 OB Spectral data)
- **2007 – 2020** – Advanced Acoustic Model *(AAM)* V2
  - Evolved from RNM, includes helicopters, tiltrotors and fixed wing aircraft

**Dual-Use:**
- **1990 - 2020** – **BaseOps** – Air Force Procedure for Predicting Aircraft Noise Around Airbases

**Current Tools in Use for NEPA:**
- FAA – AEDT (integrated)
- DOD – AAM* (simulation)
- DOD – NoiseMAP (integrated)

* - currently limited use for NEPA
Aviation Environmental Design Tool (AEDT)

- Integrated Model based on noise fraction
- Long legacy for use in regulatory studies
  - Noise, Emissions, Air Quality
  - Local, Regional and Global capabilities
- Takes into account:
  - Operating Condition / Flight Mode
  - Source Acoustics: Noise-Power-Distance data
    - Spectral Classes
    - Directivity (Start of takeoff roll, NPD R/C/L, helo static)
  - Line of Sight Blockage (shielding)
  - Atmospheric conditions
- Acoustic Metric Results include:
  - DNL, SEL (dBA, dBc), CNEL, Time Above, Time Audible
  - PNL, EPNL, Max Metrics, NEF, WECPNL

Integrated Model Concept:

Noise Fraction Source Plotkin et al, 2008

Source: FAA
Simulation Modeling via AAM

- Built around point source moving incrementally on track
- Computes noise time history including Time Varying Loudness
  - 1/12 Octave Band Analysis Modes
  - Mixed Fidelity “Pearls on Strings” analysis modes
- Requires 3-D spectral noise sources
- Takes into account:
  - Operating Condition / Flight Mode
  - Source spectrum/directivity
  - Local ground surface
  - Terrain
  - Buildings (shielding)
  - Atmospheric conditions (wind, temp gradients)
- May compute any metric based on spectral time history at receivers

* Extension of AAM for eVTOL funded by Uber Elevate

Pearls on Strings Representation

Noise Sphere Source: Page et al, 2010
Challenges

- **Noise Certification** – U.S. Federal jurisdiction
- **Airport Compatible Land Use** – U.S. Federal jurisdiction
- **Heliport / Vertiport Compatible Land Use** – Determination by local jurisdictions
  - Industry Standards and Best Practices can be beneficial here
- **Identify Metrics & Measures**
  - Current metrics (DNL, EPNL) focused on Annoyance
  - Considerations include: time varying, sound quality & character, ambient environs (TVL, audibility & detection based metrics)
- **Expand Modeling & Measurement Capabilities**
  - Ability to model eVTOL flights amongst communities accounting for ambient soundscape, urban environments / complex terrain

Need for **Data, Consensus Standards & best practices**