AEE Efforts on Helicopters, UAS and UAM

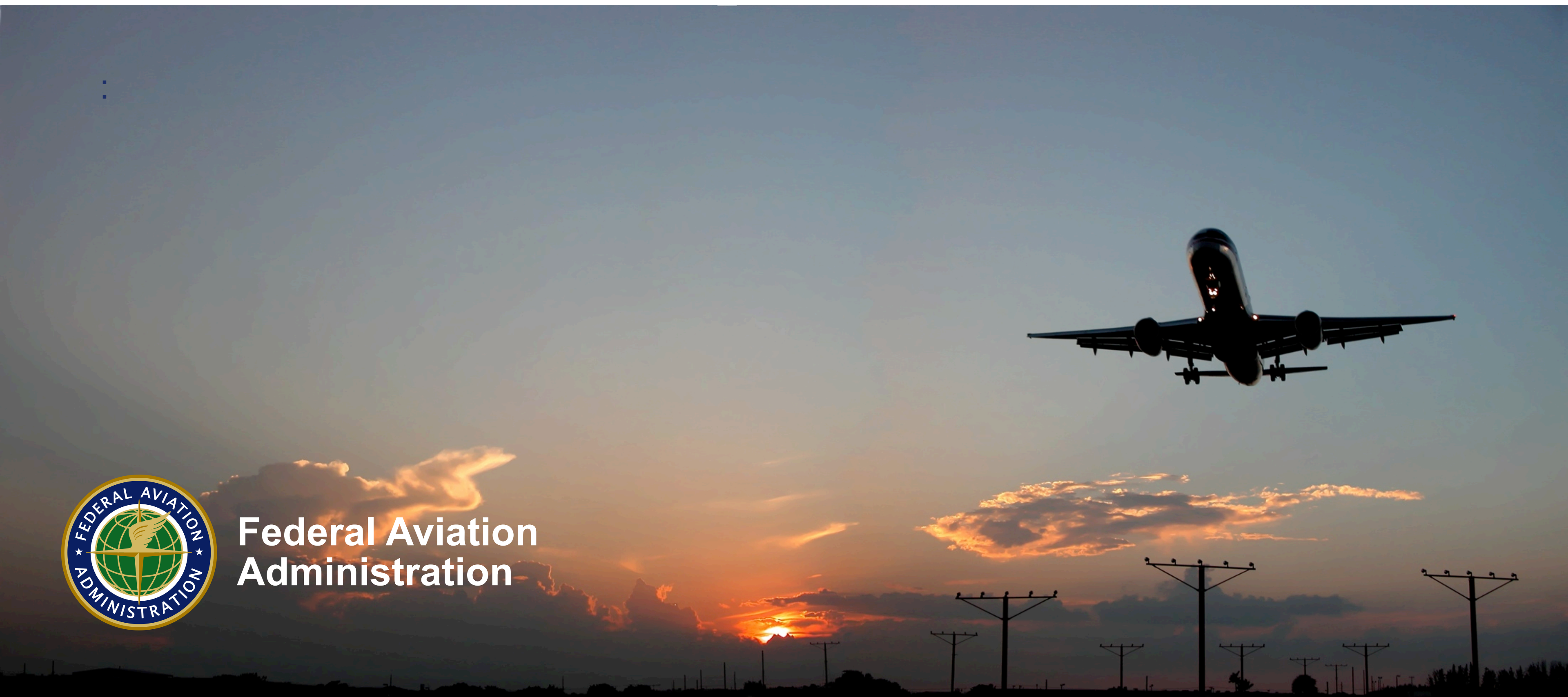
Federal Aviation Administration

Presented to: REDAC

By: Donald Scata, Eric Elmore

Date: September 10, 2019

Unmanned Aircraft Noise Certification Status



Federal Aviation Administration

Unmanned Aircraft Types

- **Unmanned Aircraft (Drones, UAS, UAV, UAM, Air Taxi, On-Demand Mobility, RPAS, eVTOL, etc.)**
  - Research is underway to understand the potential noise impacts of UA and to develop appropriate noise certification process for UA
  - The noise generation mechanisms for manned or unmanned aircraft are the generally the same. However, unique operational airspace of UA introduces new challenges

Unique qualities of UA noise (1 of 3)

- **Broader Operability - not limited to airport vicinity**
  - Operations in proximity to residences, schools, places of business, and recreation areas
  - Number of operations anticipated to be higher than what community is currently experiencing
  - New concepts in operation such as urban air mobility, air taxis, vertiports, last-mile delivery, etc.

Unique qualities of UA noise (2 of 3)

- **Noise characteristics in some cases will be different from typical aircraft:**
  - Noise-generating mechanisms different from traditional aircraft:
    - Electric propulsion, hybrid-configuration, multiple rotors, interaction between lifting and propulsion rotors, ducting, etc.
  - Spectral content of UA noise is likely to be of concern:
    - Multiple simultaneous tones – sometimes with dynamic, shifting frequencies
    - More sound energy in higher frequency range due to shorter sound propagation distances - Atmospheric attenuation at higher frequencies will not be as effective as for conventional aircraft
    - Abrupt onset of sound due to intermittent shielding from local structures

Example - Helicopter Design vs UAM (3 of 3)

Design Parameter	Helicopter	Representative UAM
Lifting Configuration	1 Main Rotor	Multiple Rotors / Wing
Thrust	Collective Pitch	Rotor Mechanism
Speed	Rotor Speed Fixed	Not Fixed
Flight Operations	Human Pilot	Automated / Autonomous

EXISTING CERTIFICATION AUTHORITY AND REGULATIONS

- 49 U.S. Code Section 44715 – Controlling aircraft noise and sonic boom
  - Noise certification and testing requirements; 14 CFR Part 36
- Clean Air Act Sections 231 and 232
  - Fuel venting and exhaust emission requirements for turbine engine powered airplanes; 14 CFR Part 34

Environmental Review

- All federal agencies have to comply with the National Environmental Policy Act (NEPA) when proposing major federal actions
- Actions authorized by the Small UAS Rule are covered by a categorical exclusion (CATEX) which satisfied FAA's NEPA obligations for the Part 107 regulations.
- Additional federal actions needed to authorize UAS operations may be subject to further environmental analysis, although we anticipate that many would be covered by a CATEX.
- Data collected under the IPP MOAs will help inform future FAA NEPA reviews and other environmental determinations.

FAA's Significant Noise Threshold

The action would increase noise by DNL[7] *1.5 dB or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe*. For example, an increase from DNL 65.5 dB to 67 dB is considered a significant impact, as is an increase from DNL 63.5 dB to 65 dB.

FAA-sponsored UA Noise Research

Part One - Measure and collect certification-quality noise level data:

- Fixed wing – Appendix G of Title 14, Part 36
  - Flight procedure: [Simulated] takeoff test at maximum weight
  - Noise metric: A-weighted maximum level, L_{ASmx}
  - Sensor: Inverted microphone over a ground plate

- Rotary wing – Appendix J of Title 14, Part 36
  - Flight procedure: Level fly-over at maximum weight and speed
  - Noise metric: A-weighted Sound Exposure Level, SEL (L_{AE})
  - Sensor: Pole-mounted (4 foot height) microphone

UA Noise measurements

- **Instrumentation includes 3 channels of audio recording:**
  - Centerline microphone mounted for grazing incidence at height of 1.2 m above local ground surface
  - Centerline inverted ground-plane microphone installed per Part 36 Appendix G / SAE ARP4055 specifications
  - Laterally-offset inverted ground-plane microphone
  - Real-time meteorological data (temperature, relative humidity, and wind speed and direction)
  - Accurate Time Space Position Information, synchronized between acoustic recording, meteo data and TSPI data.

UAS Integration Pilot Program (IPP)

- The week of July 18, 2019, conducted noise flight-testing of several unmanned aircraft in cooperation IPP Lead Participant Choctaw Nation Oklahoma (CNO).

- The unmanned aircraft tested were:

  - Yuneec Typhoon H (4.5 lb. hexcopter);
  - DJI M200 (13.5 lb. quadcopter);
  - Gryphon Dynamics BFD (55 lb. octocopter); and
  - Skywalker X-8 (7.5 lb. pusher fixed-wing).

UA Noise Research
Working with stakeholders

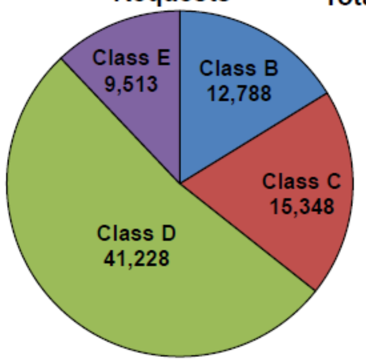
- AEE and Volpe actively participating in various efforts to understand and develop methodologies for measurement, analysis and evaluation of UA noise including:
  - NASA Acoustics Technical Working Group
  - NASA UAM Noise WG
  - ASA S-12 WG58
  - INCE UAS Noise Workshops
- Will also be reaching out to other agencies and organizations for collaboration on UA noise research

UAS report card July 22, 2019

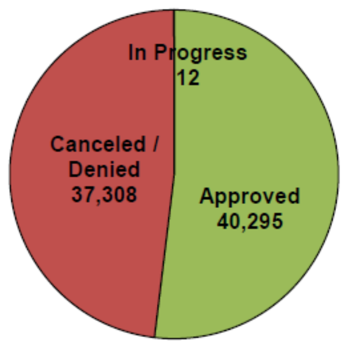
Part 107 Airspace Processing

Non-LAANC Airspace Requests

Total Airspace Waiver/Authorization Requests



Total Airspace Waiver/Authorizations Processed



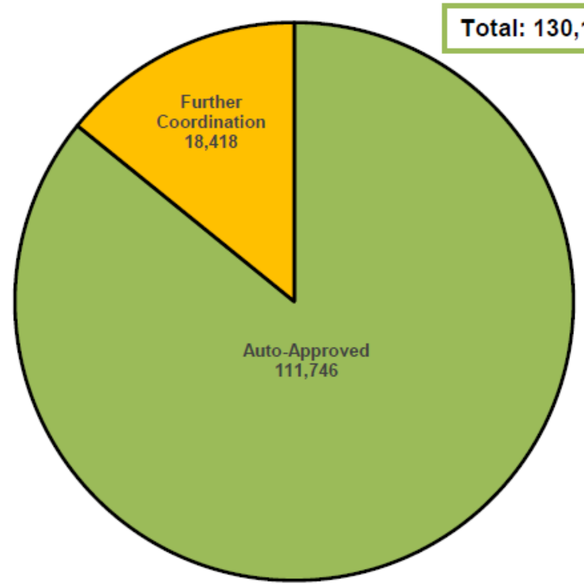
Total Approvals	Auths	Waivers	Total
Class B	5,335	18	5,353
Class C	6,811	49	6,860
Class D	24,825	99	24,924
Class E	3,136	22	3,158
TOTAL	40,107	188	40,295

Total Waiver Requests processed as Authorizations (conversions): 1,228

LAANC Airspace Requests

Incoming Requests (Total)

Total: 130,164*



*Activity through June 30, 2019

Research Roadmap

Research

UAS Focus Areas

FOCUS AREAS represent key challenges for the safe and effective integration of UAS operation in the NAS. Research activities under these focus areas inform policies, procedures, capabilities and systems, requirements and other research outcomes enabling UAS integration.

- **Command and Control (C2):** C2 research activities inform the development of systems, standards and requirements for a secure and reliable command and control link between the airborne vehicle and the control station. C2 is critical to support safe UAS operations, including BVLOS, and to prevent aircraft "fly-aways".
- **Communication:** Communications research activities inform the development of procedures, systems, requirements and other research outputs enabling PIC-ATC communications, including voice and data communications.
- **Detect and Avoid (DAA):** DAA research activities inform standards and requirements for the development of safe and effective detect-and-avoid systems to ensure UAS evade all hazards, including manned aircraft and other UAS. DAA is often an essential component of flights operating BVLOS without visual observers.
- **Environment:** Environment research activities focus on quantifying the noise and emissions from UAS, developing the tools to model their environmental performance, and developing an appropriate schema for noise and emissions certification, supporting compliance with the National Environmental Policy Act (NEPA), and minimizing disturbance to the public.
- **Human Factors:** Human Factors research activities focus on the human elements of safely operating UAS in the NAS. This includes understanding the interactions between the human and the machine to incorporate the appropriate safeguards, alerts, and displays. This also includes qualifications and requirements for the pilot and crew.
- **Navigation:** Navigation research activities inform standards and requirements for reliable, accurate, and continuous navigation capabilities, to include a backup navigation capability that ensures the unmanned aircraft flies the intended route and remains clear of unauthorized/sensitive areas.
- **Reliability:** Reliability research activities focus on enabling the FAA to determine acceptable target levels of reliability for UAS integration, based on what is appropriate for the different types of aircraft, operations, and intended airspace. This must include research and

ACRP 03-50

Project Data	
Funds:	$350,000
Staff Responsibility:	Joseph D. Navarrete
Research Agency:	Ascension Group, LLC
Principal Investigator:	Pamela Cohn
Effective Date:	7/3/2019
Completion Date:	10/2/2020

- **An Airport-Centric Study of the Urban Air Mobility Market**
- The objective of this research is to produce a report that assesses the potential impacts of Urban Air Mobility (UAM) on airports of different sizes and having different levels of activity. The report should include, at a minimum:
- A discussion of the UAM market, including technologies, regulatory environment, use cases (e.g., passenger, cargo, and air ambulance), activity projections, and financial viability;
- A discussion of potential short- and long-term UAM impacts and opportunities for the airport industry;
- Tools (e.g., matrices, Venn diagrams, flow charts, decision trees) to provide insight into how an individual airport's unique characteristics and local socioeconomic conditions could define a potential range of impacts and opportunities from UAM;
- Planning considerations for airports to prepare for the range of identified impacts and opportunities for the following subjects:
  - Passenger, cargo, and aircraft activity;
  - Operations and maintenance;
  - Short-term and long-term airside, terminal, and landside facility requirements;
  - Financing, including revenue generation;
  - Safety and security;
  - Community (e.g., noise, environmental, and compatible land use);
  - Stakeholders (e.g., tenants and business partners); and
  - Opportunities for business development.
- Case study examples (1) describing current and emerging uses of UAM at airports and (2) illustrating how airports could apply the tools and considerations above; and
- List of resources and contacts to help airports learn more about and engage in UAM.

•https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4624

ASSURE

- **eCommerce, Emerging UAS Network and Implications on NAS Integration**

- Period of Performance: Time of award – 30 months

- Researchers at the FAA's ASSURE UAS Center of Excellence (COE), will conduct surveys, assessments, analyses and simulation to support the creation of a notional nationwide commercial UAS delivery network framework that is both integrated with, and supplemental to, the existing commercial delivery system. The researchers will consider key factors such as the geography and structure of the existing package delivery network, the demographics of likely delivery customers, effective radius of service from network hubs, and the costs of service provision to arrive at candidate network design. Once the design has been completed and optimized, analyses and simulations will be conducted to determine the potential impacts of the network upon the affected classes of airspace, interaction with other air traffic, overall ground/aviation safety and the environment, as well as potential integration with NASA's proposed unmanned traffic management (UTM) system. The resultant conclusions are intended to support an FAA risk and hazard analysis to identify where and how UAS-related safety risks are most likely to appear, so that the FAA can effectively target its resources based upon estimated safety risk.
  - Commercial delivery operations, by nature, are conducted within or in close proximity to business and residential areas that are likely to be highly-sensitive to pollution, particularly the noise generated from a high volume of flights conducted in close proximity to communities. The ability to measure and predict the sound generation and propagation from a UAS or a network of UAS is important to quantifying the noise impact on population, and helps inform the design of quieter UAS. Other environmental concerns may include visual pollution, where a density of a UAS network over a populated area may interfere with visual comfort of residents, or air pollution if vehicles are powered by small fuel engines.

FAA Rotorcraft Noise Research Overview

Federal Aviation Administration

Presented to: **REDAC 2019**

By: Rick Riley

Date:

OUTLINE – 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.

MODELING

- PSU-WOPWOP: A physics based model that can predict steady state and maneuvering rotorcraft operations
- New Design Prediction Capability: PSU-WOPWOP can predict rotorcraft noise for new designs
- PSU (Brentner, Mrunali) Publications: Papers for VFS Forum and AIAA Conference
- Aviation Sustainability Center (ASCENT) Opportunities: Utilizes Universities and Industry to participate in research with benefit of cost sharing

TESTING AND VALIDATION

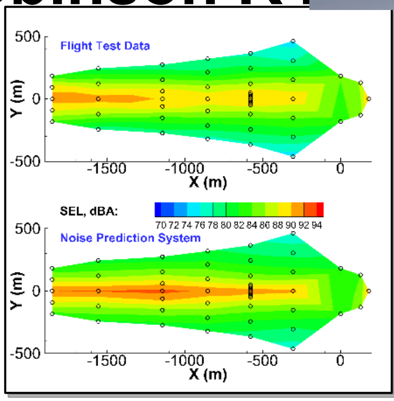
NASA/FAA 2019 Noise Test

- Testing was conducted in June and July 2019 at Coyle Field New Jersey
- Three aircraft were selected to represent heavier rotorcraft

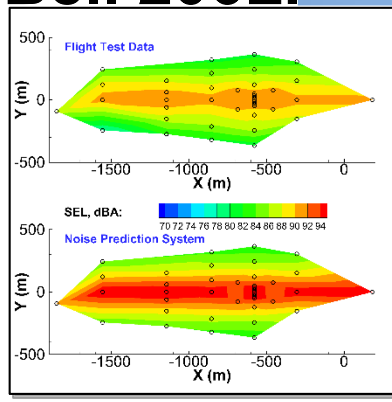
Bell 205 "Huey | **Agusta/Wesland AW139** | **Sikorsky S-76A**

MODEL VALIDATION LEVEL FLIGHT 80 KT

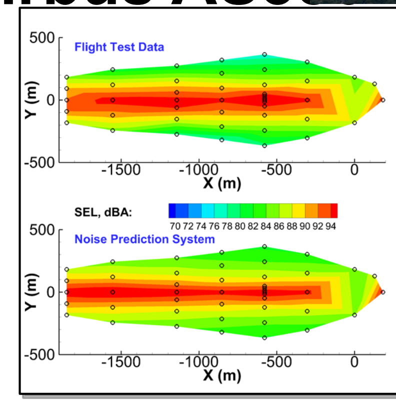
•Robinson R4



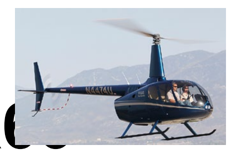
•Bell 206L

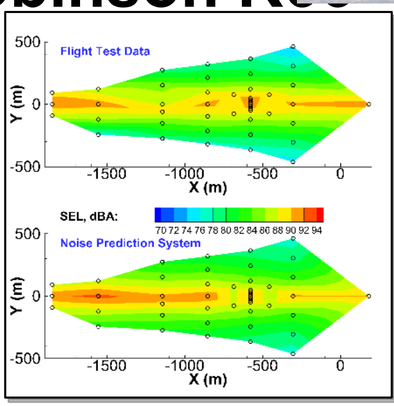


Airbus AS35

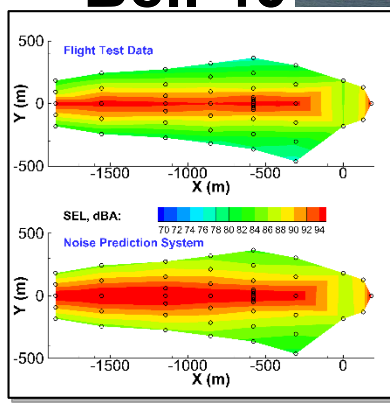


•Robinson R6





•Bell 40



•Key Takeaways

- Noise Prediction System captures Sound Exposure Levels well
  - Agreement within 2-4 SELdBA (often <2)
  - Small overprediction for Robinson and Bell helicopters
- Changes between helicopters captured

WHAT IS FLY NEIGHBORLY ?

- Fly Neighborly is a holistic approach to mitigating helicopter noise including:
  - Noise abatement flight procedures
  - Route planning
  - Community outreach to foster better relationships between communities and helicopter operators
- A successful Fly Neighborly program can include addressing technical. topographical, meteorological, emotional, and political factors
- The program was initiated by Helicopter Association International (HAI) and is being supported by numerous private and public partners, including the FAA.

Questions?

UNMANNED AERIAL SYSTEMS (UAS)

THANK YOU