T15.04  Full-Scale (2+ Passenger) Electric Vertical Takeoff and Landing (eVTOL) Scaling, Performance, Aerodynamics, and Acoustics Investigations

Lead Center: AFRC

Participating Center(s): ARC, GRC, LaRC

Scope Title
Full-Scale (2+ Passenger) Electric Vertical Takeoff and Landing (eVTOL) Scaling, Performance, Aerodynamics, and Acoustics Investigations

Scope Description
NASA's Aeronautics Research Mission Directorate (ARMD) laid out a Strategic Implementation Plan for aeronautical research aimed at the next 25 years and beyond. The documentation includes a set of Strategic Thrusts—research areas that NASA will invest in and guide. It encompasses a broad range of technologies to meet future needs of the aviation community, the nation, and the world for safe, efficient, flexible, and environmentally sustainable air transportation. Furthermore, the convergence of various technologies will also enable highly integrated electric air vehicles to be operated in domestic or international airspace. This subtopic supports ARMD’s Strategic Thrusts #1 (Safe, Efficient Growth in Global Operations), #3 (Ultra-Efficient Commercial Vehicles), and #4 (Safe, Quiet, and Affordable Vertical Lift Air Vehicles).

Proposals are sought in the following areas: (1) design and execution of experiments to gather research-quality data to validate aerodynamic and acoustic modeling of full-scale, multirotor eVTOL aircraft, with an emphasis on rotor-rotor interactions and (2) development and validation of scaling methods for extending and applying the results of instrumented subscale model testing to full-scale applications. This solicitation does not seek proposals for designs or experiments that do not address full-scale eVTOL applications. Full-scale is defined as a payload capacity equivalent to two or more passengers, including any combination of pilots, passengers, or ballast.

Proposals should address the following if applicable:

(1) Clearly define the data that will be provided and how it will help NASA and the community accelerate the design cycle of full-scale eVTOL aircraft. Also define what data will be collected and data that will be considered proprietary. Data includes vehicle specifications, models, results, flight test data, and any other information relative to the work proposed.

(2) If the proposal cannot address the full topic, please state a reasoning/justification.

(3) Clearly propose a path to commercialization and include detail with regards to the expected products, data, stakeholders, and potential customers.

Expected TRL or TRL Range at completion of the Project
Primary Technology Taxonomy

Level 1

TX 15 Flight Vehicle Systems

Level 2

TX 15.1 Aerosciences

Desired Deliverables of Phase I and Phase II

- Software
- Hardware
- Analysis
- Research
- Prototype

Desired Deliverables Description

Expected deliverables of Phase I awards may include but are not limited to:

- Initial experiment test plans for gathering experimental results related to the aerodynamic and/or acoustic characteristics of a multirotor eVTOL aircraft, with an emphasis on interactions between rotors and between the rotors and the vehicle structure for either:
  - A full-scale flight vehicle.
  - A subscale vehicle with fully developed methods for scaling the results to full scale.
- Expected results for the flight experiment using appropriate design and analysis tools.
- Design (CAD, OpenVSP, etc.) and performance models for the vehicle used to generate the expected results.
- Preliminary design of the instrumentation and data recording systems to be used for the experiment.

It is recommended that awardee participate in kickoff, midterm, and final briefings as well as provide a final report.

Expected deliverables of Phase II awards may include but are not limited to:

- Experimental results that capture aerodynamic and/or acoustic characteristics of a multirotor eVTOL aircraft, with an emphasis on interactions between rotors and between the rotors and the vehicle structure for either:
  - A full-scale flight vehicle.
  - A subscale vehicle with results extrapolated to full scale.
- Design (e.g., CAD, OpenVSP, etc.) and performance models for the experimental vehicle.
- Experimental data along with associated as-run test plans and procedures.
- Details on the instrumentation and data logging systems used to gather experimental data.
- Comparisons between predicted and measured results.

It is recommended that awardee participate in kickoff, midterm, and final briefings as well as provide a final report.

State of the Art and Critical Gaps

Integration of Distributed Electric Propulsion (DEP) (4+ rotors) systems into Advanced Air Mobility eVTOL aircraft involves multidisciplinary design, analysis, and optimization (MDAO) of several disciplines in aircraft technologies. These disciplines include aerodynamics, propulsion, structures, acoustics, and/or control in traditional aeronautics-
related subjects. Addressing ARMD’s Strategic Thrust #1 (Safe, Efficient Growth in Global Operations), #3 (Ultra-
Efficient Commercial Vehicles), and #4 (Safe, Quiet, and Affordable Vertical Lift Air Vehicles) innovative
approaches in designing and analyzing highly integrated DEP eVTOL aircraft are needed to reduce the energy use,
noise, emissions, and safety concerns. Due to the rapid advances in DEP-enabling technologies, current state-of-
the-art design and analysis tools lack sufficient validation against full-scale eVTOL flight vehicles. This is especially
true in the areas of aerodynamics and acoustics.

Relevance / Science Traceability

This subtopic supports ARMD’s Strategic Thrusts #1 (Safe, Efficient Growth in Global Operations), #3 (Ultra-
Efficient Commercial Vehicles), and #4 (Safe, Quiet, and Affordable Vertical Lift Air Vehicles). Specifically, the
following ARMD program and projects are highly relevant.

NASA/ARMD/Advanced Air Vehicles Program (AAVP):

- Revolutionary Vertical Lift Technology (RVLT) Project
- Advanced Air Transport Technology (AATT) Project
- Convergent Aeronautics Solutions (CAS) Project
- Transformational Tools and Technologies (TTT) Project
- University Innovation (UI) Project
- Advanced Air Mobility National Campaign

References

- ARMD/Advanced Air Transport Technology (AATT) Project: https://www.nasa.gov/aeroresearch/programs/aaavp/aatt
- ARMD/Revolutionary Vertical Lift Technology (RVLT) Project: https://www.nasa.gov/aeroresearch/programs/aaavp/rvlt
- ARMD/Convergent Aeronautics Solutions (CAS) Project: https://www.nasa.gov/aeroresearch/programs/tacp/cas
- ARMD/Transformational Tools and Technologies (TTT) Project: https://www.nasa.gov/aeroresearch/programs/tacp/ttt
- ARMD/University Innovation (UI) Project: https://www.nasa.gov/aeroresearch/programs/tacp/ui
- ARMD Strategic Implementation Plan: https://www.nasa.gov/aeroresearch/strategy
- ARMD Advanced Air Mobility National Campaign: https://www.nasa.gov/uamgc