NASA SBIR 2020 Phase I Solicitation

A1.02 Quiet Performance - Aircraft Propulsion Noise

Lead Center: GRC

Participating Center(s): LaRC

Technology Area: TA15 Aeronautics

Scope Description

Innovative methods and technologies are necessary for the design and development of efficient, environmentally acceptable aircraft. In particular, for passenger aircraft, the impact of aircraft noise on communities around airports is the predominant limiting factor on the growth of the nation's air transportation system. Reductions in aircraft noise could lead to wider community acceptance, lower airline operating costs where noise quotas/fees are employed, and increased potential for air traffic growth on a global scale.

Therefore, in support of the Advanced Air Vehicles Program (AAVP), Integrated Aviation Systems Program (IASP), and Transformative Aeronautics Concepts Program (TACP), improvements in technologies and methods for aircraft propulsion noise prediction, diagnostics, and reduction for both subsonic and supersonic aircraft are sought. Innovations in the following specific areas are solicited:

Noise Reduction

- Advanced liners including broadband liners (i.e., liners capable of appreciable sound absorption over at least two octaves) and low-frequency liners (i.e., liners with optimum absorption frequencies half of the current ones but without increasing liner depth); engine hot-section liners;
- Low-noise propulsor concepts that are significantly quieter than the current generation fans and open rotors;
- Concepts for active control of propulsion broadband noise sources including fan, open rotor, jet, compressor, combustor, and turbine;
- Adaptive flow and noise control technologies including smart structures and materials for inlets, nozzles, and low-drag liners;
- Concepts to mitigate the effects of distorted inflow on propulsor noise;

Noise Prediction

- High-fidelity fan and turbine noise prediction models including Large Eddy Simulation of broadband noise, 3D fan and turbine acoustic transmission models for tone and broadband noise;
- Accurate models for prediction of installed noise for jet surface interaction, fan inlet distortion, and open rotors;
Noise Diagnostics

- Tools/Technologies for quantitative characterization of fan in-duct broadband noise in terms of its spatial and temporal content;
- Phased array and acoustical holography techniques to measure realistic propulsion noise sources in low-signal-to-noise ratio wind tunnel environments;
- Characterization of fundamental jet noise sources and structures;
- Innovative measurement of radiated acoustic fields from aeroacoustic sources;
- Novel and robust combustion noise measurement techniques.

References

AAVP - Advanced Air Transport Technology (AATT) Project:
https://www.nasa.gov/aeroresearch/programs/aavp/aatt

AAVP - Commercial Supersonic Technology (CST) Project: https://www.nasa.gov/aeroresearch/programs/aavp/cst

TACP - Transformational Tools and Technologies (TTT) Project:
https://www.nasa.gov/aeroresearch/programs/tacp/ttt

Expected TRL or TRL range at completion of the project: 2 to 5.

Desired Deliverables of Phase II

Prototype, Analysis, Hardware, Software, Research

Desired Deliverables Description

Concepts and technologies that demonstrate a potential for engine component noise reduction, or demonstrate characteristics that could be incorporated into a more sophisticated noise control solution for aircraft engines.

State of the Art and Critical Gaps

Current state-of-the-art solutions for propulsion noise reduction rely heavily on relatively modest changes to the engine architecture and/or passive noise reduction technologies such as acoustic liners, blade/vane count optimization, or vane sweep and/or lean. They do not incorporate advanced materials, adaptive mechanisms, or active noise control systems that can modify the acoustic performance of the component(s) of interest based on the noise state of the engine or aircraft. Such materials, mechanisms, and systems are currently at various stages of maturity, but in general they have not been sufficiently developed to meet certifiability, reliability, and robustness criteria. Novel material systems that could be applied to engine component noise sources are needed, such as shape memory alloy actuators, or active or adaptive systems. High-fidelity numerical tools are beginning to be used for predicting engine component noise. However, they remain too resource-intensive for routine use for design and analysis work. Medium-fidelity prediction tools that can be used for rapid-turn-around evaluations at design and analysis stages are highly desirable. Advanced flow and noise diagnostic techniques that can provide more direct linkage between the noise generating flow features and/or provide more detailed spatio-temporal descriptions of the sound field are also much needed.

Relevance / Science Traceability

AAVP: The Advanced Air Transport Technology (AATT) and Commercial Supersonic Technology (CST) Projects would benefit from noise reduction technologies that could reduce the aircraft noise footprint at landing and takeoff. Configurations with novel engine placement, such as above the fuselage, can reduce the noise footprint, but technologies are needed to efficiently model the performance and noise impacts of these novel engine installations.

TACP: The Transformational Tools and Technologies (TTT) Project would benefit from tool developments to enhance the ability to consider acoustics earlier in the aircraft design process. The TTT project would also benefit from the development and demonstration of simple material systems, such as advanced liner concepts with reduced drag or adaptive material and/or structures that reduce noise, as these component technologies could
have application in numerous vehicle classes in the AAVP portfolio, including subsonic and supersonic transports as well as vertical lift vehicles.