SON Number: WPSON-14-03 **October 25, 2012**

Strategic Environmental Research and Development Program (SERDP)

FY 2014 STATEMENT OF NEED

Weapons Systems and Platforms (WP) Program Area

FULL SCALE MILITARY TACTICAL AIRCRAFT ENGINE NOISE SOURCE/MECHANISM IDENTIFICATION

1. Objective of Proposed Work

The objective of this Statement of Need (SON) is to improve the fundamental understanding of noise generation in supersonic military jet aircraft engines through the acquisition and interpretation of relevant flow and noise data. These data will enable aeroacoustic researchers to identify flow features that must be incorporated in laboratory experiments and numerical models used to predict and ultimately reduce noise from these engines.

The Department of Defense (DoD) operates increasingly higher performance, supersonic military jet aircraft using very high power, low bypass, supersonic jet flow gas turbine engines. With the growth of communities surrounding DoD installations, noise from the operation of military aircraft is an increasing concern. Despite increasingly restrictive aircraft operational guidelines, DoD high performance jets are significantly louder than commercial aircraft in all operational modes. Additionally, some DoD personnel perform duties in the acoustic near-field of engine plumes and are exposed to very high noise levels that are a known safety concern.

Current noise prediction capabilities and reduction technologies rely on numerical modeling and laboratory scale measurements that may or may not incorporate realistic flow features present in the exhaust of actual engines. No database exists with correlated flow, performance, and noise measurements for high-performance gas turbine engines. Thus, it is not possible to close the gap between the understanding of jet noise sources in laboratory and numerically modeled jets and those in the exhaust of high performance military engines under actual operating conditions.

To address the objective, engine tests must include operation of one or more suitable engines over the full operating range from idle to maximum afterburner. The measurements of interest include: (1) thrust and other engine performance parameters measured and recorded with sufficient accuracy to ensure that the time varying operating conditions of the engine are well known and can be correlated with all other data, (2) mean temperature and velocity as well as turbulent velocity statistics through the jet plume acquired with sufficient resolution to allow for the correlation of full scale engine features with numerical models and laboratory-scale measurements, (3) highly detailed near-field pressure and/or noise measurements that allow for the correlation of flow features with the production of noise, and 4) detailed far-field noise measurements. The engine operating conditions, and flow and acoustic parameters must be

measured simultaneously. Suitable test facilities must be able to support the safe operation of a high performance engine, make accurate measurements of thrust and other engine operating parameters, and make accurate measurements of required noise-related parameters. Government test facilities exist that are suitable and potentially available for purposes of this SON. In addition, military engines exist in inventory that may be used as Government Furnished Equipment (GFE) for purposes of this SON. For information on cost and availability of assets, Points-of-Contact from the following services/agencies are provided:

U.S. Department of Navy – Tom Weiss, 301-757-3420, thomas.weiss@navy.mil
U.S. Air Force – Barry V. Kiel, barry.kiel@wpafb.af.mil
National Aeronautics and Space Administration – Brian Fite, brian.fite@nasa.gov

2. Expected Benefits of Proposed Work

Successful completion of this work will provide a better understanding of the major sources and mechanisms of noise generated by the engines of high-performance military aircraft engines. The results are expected to: (1) enhance aeroacoustic analogies using noise-source models derived from Reynolds averaged Navier-Stokes solutions, (2) validate and improve large eddy simulation solutions used to predict noise from large-scale structures in relevant jet exhausts, (3) quantify linear and non-linear propagation regions for predictive code development, (4) quantify near-field noise for predictive code development, and (5) guide development of realistic experiments designed to understand and reduce jet noise sources in high-speed, hot jets. This knowledge will enable the development of technologies to predict and reduce noise from engines while minimizing the impact to engine performance characteristics.

3. Background

The DoD is aware of the issues and impacts on the environment from noise generated by high performance supersonic military aircraft such as the F-35 Lightning II Joint Strike Fighter (JSF), F-22, and F/A-18 E/F. Current and potential U.S. and international noise regulations and policies threaten to impact future basing considerations as well as operations and training requirements. Research and development activities focused on reducing the noise generated by high performance supersonic aircraft are limited.

DoD supersonic aircraft exhibit performance characteristics which are realized by exceptional power-to-weight ratios. The techniques used to achieve the exceptional speeds and power outputs also contribute to acoustic production even when aircraft are flown at subsonic speeds. Newer aircraft generate intense noise levels well above any current commercial or transport category aircraft in all operational modes. These noise levels are already causing significant pressure for reductions in aircraft numbers and/or available airspace for training and operations. Likewise, Veterans Administration claims related to hearing impairment are the single highest category of claims, and are increasing. Changes in operational and flight procedures can reduce the impacts to the surrounding communities but cannot eliminate all safety and environmental impacts. Research efforts are needed to understand, and effectively reduce, the noise from these jet engines.

Effective noise reduction technologies cannot be developed through a cut-and-try approach on a real aircraft. The costs associated with this type of approach are prohibitive and efforts typically

do not lead to success. Technology development occurs through a combination of numerical modeling and laboratory experiments. However, no relevant database, including comprehensive flow and noise measurements from a real engine, exists to guide technology developments in the laboratory or numerical simulations. This SON aims at obtaining a relevant database and closing the gap between our understanding of noise sources in simplified experiments and simulations and those present in real, supersonic, jet-engine exhausts.

Prior tests of full scale military supersonic engines with noise measurements have been performed. However, no measurements of supersonic jet engines are available that include sufficient data needed to correlate and compare numerical models or scaled/wind tunnel test data. Instrumentation technologies to measure the properties of a supersonic jet plume have recently been advanced through other DoD and industry research efforts and such measurements using this instrumentation are expected to yield higher quality results.

4. Cost and Duration of Proposed Work

The cost and time to meet the requirements of this SON are at the discretion of the proposer. Two options are available:

Standard Proposals: These proposals describe a complete research effort. The proposer should incorporate the appropriate time, schedule, and cost requirements to accomplish the scope of work proposed. SERDP projects normally run from two to five years in length and vary considerably in cost consistent with the scope of the effort. It is expected that most proposals will fall into this category.

Limited Scope Proposals: Proposers with innovative approaches to the SON that entail high technical risk or have minimal supporting data may submit a Limited Scope Proposal for funding up to $150,000 and approximately one year in duration. Such proposals may be eligible for follow-on funding if they result in a successful initial project. The objective of these proposals should be to acquire the data necessary to demonstrate proof-of-concept or reduction of risk that will lead to development of a future Standard Proposal. Proposers should submit Limited Scope Proposals in accordance with the SERDP Core Solicitation instructions and deadlines.

5. Point of Contact

Bruce D. Sartwell
Program Manager for Weapons Systems and Platforms
Strategic Environmental Research and Development Program (SERDP)
4800 Mark Center Drive, Suite 17D08
Alexandria, VA 22350-3605
Phone: 571-372-6399
E-Mail: Bruce.Sartwell@osd.mil

For Core proposal submission due dates, instructions, and additional solicitation information, visit the SERDP web site at www.serdp-estcp.org/Funding-Opportunities/SERDP-Solicitations.