STATEMENT OF OBJECTIVES (SOO)

Research for Integrated Vehicle Aerodynamic Technologies (RIVAT) Two-Step Open BAA

I. Background

The Aerospace Vehicles Division (RQV), Aerospace Systems Directorate (RQ), Air Force Research Laboratory (AFRL) conducts vehicle aerodynamic research in the following areas:

1) Fundamental and Applied Fluid Dynamics
2) Aircraft Design and System Enhancements
3) Flow Control Applications
4) Weapons Integration and Cavity Flow
5) Propulsion Integration
6) Aero-Optics Interactions
7) Technology Applications and Operational Analysis

The primary goal of this research is to enable the discovery, development, and transition of aerodynamic technologies to enhance current and future air vehicles.

II. Description of Effort

Each research area is described in more detail below.

1. Fundamental and Applied Fluid Dynamics

Fundamental and applied fluid dynamics is central to Air Force vehicle flight performance and mission success. Research in this area is intended to further understanding of internal and external aerodynamic flow physics and to apply this knowledge to better predict vehicle performance and integrate into future vehicles. Of particular interest are multidisciplinary investigations such as fluid-structure interactions (jet impingement, propeller slipstream interactions, vortex impingement, etc.), unsteady fluid dynamics (both at micro- and macro-levels), and technology development harnessing these interactions for increasing mission performance/effectiveness. Relevant approaches encompass analytical, computational, and experimental efforts to investigate current geometries and to incorporate into future designs.

2. Aircraft Design and System Enhancements

Both enhancing current systems and designing new systems requires the creative process of generating new ideas for artifacts that do not exist. Additionally, trade studies comparing the application of new technologies or technology maturation are invaluable to decision makers. Much interest exists to further develop engineering design capability (both processes and tools) to better leverage limited resources and better support well informed decision-making. Relevant research and investigations include the various trade-offs in modeling fidelities, capturing effectiveness-based design concerns, and modeling uncertainties/sensitivities.

3. Flow Control Applications

Smartly designing and applying flow control to air vehicle modifications and to future vehicle concepts is worthy of investigation to enhance capabilities and mission effectiveness. Both active and passive flow control applications are of interest including control of aerial refueling booms, flow separation/reattachment, high lift augmentation, stability and control throughout all flight regimes, and coupled effects realized through considering these possibilities early in vehicle design. The development of models over a range of predictive capability and computational complexity, including reduced order modeling, is beneficial depending on intended model use. Of particular interest is modeling the integration effects (i.e., size, weight, power, efficiencies, etc.) and operational impacts of flow control applications that could support new vehicle design.

4. Weapons Integration and Cavity Flow

Cavity flow investigations and fluid dynamic modeling around multiple bodies is important to better understand the interaction of flow fields around the air vehicle and the flow dynamics in and around weapons bays. These phenomena are also relevant to external stores, turrets, external antennae, propulsion system inlet flows, bleed air inlet dynamics, etc. Complex, unsteady, flow physics models are often necessary to capture driving effects, but trade-offs are needed to ensure efficient utilization of available engineering, computational, and experimental resources. Multidisciplinary considerations including store separation, store trajectory control, and vehicle-store interactions are especially relevant.

5. Propulsion Integration

Better understanding of the complex interactions between air vehicle aerodynamics and propulsion system fluid dynamics may lead to improved, more effective designs. Engines are embedded into a vehicle airframe for a variety of reasons surrounding mission effectiveness, so capturing the physics and operational impact is important. Improved modeling of distortions seen by embedded fans enables the use of more efficient, higher-bypass engines, especially in transonic vehicles. At supersonic flight conditions, shock wave/boundary layer interactions and other viscous fluid phenomena become increasingly important. Recent integrated propulsion applications include Over-the-Wing Nacelles (OWN), Distributed Propulsion (DP), and Boundary Layer Ingestion (BLI).

6. Aero-Optics Interactions

Minimizing energy beam degradation through the air vehicle boundary layer and other distortions is essential to mission effectiveness and system efficiency. Interference is caused by numerous effects, including turbulence, flow separation, shock waves, and other fluid density fluctuations around external protuberances such as turrets. Understanding the resulting unsteady distortions allows modeling of relevant effects to ensure energy beam applications operate as intended. Additionally, technology applications or enhancements that mitigate these losses are relevant to future efforts.

7. **Technology Applications and Operational Analysis**
   Modeling and simulation to investigate how upcoming technology applications overcome mission challenges and enhance overall effectiveness are relevant for both analyzing current systems and designing new systems. Operational analysis can also be used to drive research efforts for new technologies and alternative employment of not only material additions, but also new processes and applications. Often, new technology development enables new ways to accomplish known missions, provides additional insights with relevant evaluation metrics, and helps focus R&D resources to have the greatest impact.

III. Deliverables

See Contract Data Requirements List (CDRLs), Attachment 2 of the Broad Agency Announcement (BAA) for possible delivery items. The attached CDRL document is an example for planning purposes and each resulting award shall have its own tailored CDRL package.

IV. OPSEC

Operations Security (OPSEC) must be an integral part of our daily activities. As we maintain security on our future technologies that are vital to national interest, we must recognize and prepare for the threat poised against our technology. Department of Defense policies mandate a high degree of security throughout the acquisition process. However, heightened security awareness and threat-based countermeasures are particularly essential during the research and development phase when our technology is most vulnerable to espionage, sabotage, or exploitation. It is the obligation of each employee or persons involved on this agreement be constantly aware of and strictly adhere to security requirements designed to protect sensitive unclassified and other information and resources produced by acquisition, research and development, and technological security efforts outlined in this SOO. The recipient shall ensure employees receive training and follow appropriate Operations Security (OPSEC) measures during the performance of the agreement.