EXHIBIT B
BPA STATEMENT OF WORK
FOR
Langley Research Center Analysis, Systems Engineering, & Research (LASER) Blanket Purchase Agreement

1. **INTRODUCTION:** This Statement of Work (SOW) defines the scope and technical requirements for tasks to be performed under a Blanket Purchase Agreement (BPA) that will provide professional engineering services to NASA Langley Research Center (LaRC).

2. **REFERENCE:** This BPA is subject to GSA Schedule 871-3, Professional Engineering Services (System Design, Engineering, and Integration Services.

3. **OBJECTIVE:**

(a) The required products and services will require a broad spectrum of engineering, scientific, and management expertise, and often with substantial experience in the relevant technical disciplines. This expertise includes, but is not limited to, aerodynamics, aerothermodynamics, systems analysis, astrophysics, orbital mechanics, planetary entry, multi-disciplinary optimization, 3-D modeling, simulation, dynamic visualization, and aerospace system design, engineering, and development. This work typically involves a wide range of scientific, engineering, design, and development activities, including but not limited to, aerodynamics, mechanical, structural, thermal, propulsion, fluid systems, electrical/electronics, avionics/controls, instrumentation/advanced sensors, and manufacturing technology.

(b) The Contractor staff may be required to support efforts involving individuals from LaRC, other NASA Centers, Contractors, and/or Government agencies.

4. **SCOPE OF WORK**:

The scope of work under this BPA is necessarily broad to cover the range of activities underway at LaRC. These activities cover mission requirements from all NASA Mission Directorates and Agency-level functions. Task Orders awarded under this BPA will require engineering, scientific, and technical management expertise with appropriate levels of skill and experience. Work deliverables will be documented in a variety of ways, including but not limited to, written reports, presentations, technical papers, journal articles, engineering and working drawings, analysis reports, and operational procedures/manuals.

(a) The Contractor shall provide engineering, scientific, and/or program/project management related work products via Task Orders issued by the Contracting Officer (CO). The work products fall into the general categories described in numbered subsections 4.1 through 4.5 below.

(b) Due to wide industry involvement in NASA's programs and projects, the Contractor must be prepared to address potential Organizational Conflict of Interest issues.

(c) Task Orders issued within the scope of this BPA will typically focus on one or more aspects of a complex systems study or assessment, research and technology development, scientific mission activity, mission operations, or flight hardware development. The Task Orders may involve the following critical considerations:

(i) Specialized skills of an individual or multi-disciplinary team of individuals,

(ii) Close integration and coordination with tasks performed by NASA personnel, other Contractor staff, and/or other Government agency personnel.

(iii) Information which falls under the purview of the Commerce Control List (CCL) as defined in the Export Administration Regulations (EAR), 15 CFR Parts 730-774, and is export controlled.

(iv) Information which falls under the purview of the U. S. Munitions List (USML), as defined in the International Traffic in Arms Regulation (ITAR), 22 CFR 120-130, and which is export controlled.

(d) Task Orders may involve software development for human-rated software systems, non-human-rated space software systems, or mission-support software that could require the Contractor to be rated at Capability Maturity Model Integrated (CMMI®-SE/SW) Capability Level 2 or higher. Also, Task Orders requiring software development shall comply with NASA Procedural Requirement (NPR) 7150.2 NASA Software Engineering Requirements, according to the Requirements Mapping Matrix in Appendix D of the NPR for various classes of software defined in Appendix B of the NPR.

Task Order work requirements may involve one or more of five major topics as follows:

4.1 Research and Technology Development

LaRC performs extensive research and technology development for NASA's future space and aeronautics needs. This topic is fundamental to development of new capabilities that will advance the Agency's goals in aeronautics, space exploration, space operations, and science. Research at LaRC ranges from the most basic, fundamental subjects to more focused, applied research for development of technologies to fulfill specific Agency or National needs. LaRC's research and technology subjects cover a broad spectrum of scientific and engineering disciplines. Within this topic, work requirements may include, but are not limited to, the following activities:

(i) Aeronautics – Includes fundamental aerodynamics and aerothermodynamics (subsonic, supersonic, hypersonic); structural mechanics; material science; acoustics and vibroacoustics; flight operations of both manned and unmanned aircraft; civil airspace (air traffic control, navigation, flight management, avionics, ground systems, and safety); flight mechanics and dynamics; guidance and control; and aircraft systems, including but not limited to, mechanical, structural, fluids, electrical, propulsion, avionics, instrumentation, and advanced sensors. Work requirements will involve aeronautical engineering expertise and experience including high order computational methods, engineering analyses, experiment development, test implementation, data reduction/visualization, and data management.

(ii) Space Exploration – Includes furthering fundamental knowledge of space environments and development of technologies to enable space exploration via robotic and manned missions. The primary area of interest is NASA's Constellation Program which is focused on development of architectures, campaigns, missions, launch vehicles, space transportation systems, and surface systems for both manned and autonomous systems. The missions cover low-Earth orbit (LEO), International Space Station (ISS), exploration of the Moon and Mars, and other planetary exploration. Work requirements in this area will involve expertise in space environments, space-rated technology development, and systems design, requiring diverse engineering disciplines with appropriate levels of relevant experience.

(iii) Space Operations – Includes broad areas of focused/applied research and technology development to support mission development, mission operations, and hardware or payload development for NASA's Space Shuttle, ISS, and evolving space missions. It often requires planning and development of mission critical capabilities in a time-critical environment. Recent examples of such capabilities are a space-rated infrared camera to detect damage to Shuttle's thermal protection system (TPS), on-orbit repair

capabilities for Shuttle tiles and carbon-carbon panels, and rapid thermal-structural analyses of detected in-situ TPS damage. Work requirements in this area will involve engineering and scientific expertise with specific experience in space hardware development and space mission operations.

(iv) Science – Includes furthering fundamental knowledge in Earth science, astrophysics, heliophysics, and planetary science including lunar science. Work requirements in this area will include, but not be limited to, astronomy, celestial navigation, physics, chemistry, geology, and remote sensing of the Earth and other celestial bodies. It also requires technology development for space and atmospheric instruments and sensors on the cutting edge of scientific, engineering, and manufacturing capability, often beyond the state-of-the-art. Science mission implementation considerations to be addressed will include but not be limited to mission design, orbit mechanics, operations, instrumentation, flight systems, management, schedule, and cost.

4.2 Systems Analysis, Trade Studies, and Technology Assessment

LaRC conducts systems analyses, conceptual design studies, trade studies, and technology assessment activities for aerospace systems including, but not limited to, space transportation and launch systems; Earth observing systems, lunar and planetary exploration systems; planetary vehicles and entry systems; hypersonic aircraft and propulsion systems; advanced military and civilian aircraft; subsonic and supersonic passenger/cargo transports; and general aviation aircraft. This topic provides critical assessment of NASA programs, projects, and technologies to aid NASA Management in critical decision making and resource management. The work requires development of innovative concepts to address future Agency and National priorities. It involves critical examination of technical concepts, complete analysis of life cycle costs, reliability, and safety including predicting performance. Within this topic, work requirements will involve the following activities including, but not limited to:

(i) Systems Analyses – This activity involves development of advanced concepts and innovative technical solutions for human and robotic aerospace systems, architectures, and campaigns to answer NASA's long-term mission needs. Such analysis includes launch vehicles, science missions, space transportation systems, surface systems, and concepts of operation from point of origin to destination including all mission phases through the system life-cycle. It includes design and analysis of systems concepts, assessment of alternatives, and planning for all life-cycle phases of the mission. A critical capability is the conceptualization, visualization, and communication of complex aerospace mission concepts quickly and effectively. This work typically involves a wide range of engineering expertise and experience in varied disciplines to perform the technical and economic analyses required to identify high-payoff concepts and technologies, including but not limited to investigation of design sensitivities, cost, risk, reliability, and safety of the mission systems. System analysis, campaign analysis, and mission development for advanced aeronautics and space concepts may address time horizons from 5 to 50 years.

(ii) Trade Studies – This activity requires engineering assessments of technical alternatives at all levels including, but not limited to, complete space or aeronautics architectures, flight systems, or subsystems thereof, including structures and mechanisms, power, thermal protection, propulsion, communication and navigation, guidance and control, environmental control and life support, extravehicular activity systems, avionics, radiation mitigation, and instrumentation/advanced sensors. Trade studies will require engineering assessments of systems, subsystems, or components at varied depths from pre-conceptual to critical design and beyond. Trade studies must be conducted with a uniform, unbiased methodology at the required depth, to obtain a meaningful level of discrimination between competing ideas, concepts, systems, or technologies. These trade studies will also involve probabilistic methods to estimate the likelihood of achieving stakeholders' desired outcome. These efforts may be high-priority and short duration, to assure timely input to requestors.

(iii) Technology Assessment – This activity involves the definition of technology requirements from the architecture/mission functional needs, development and maintenance of technology and mission databases, and establishing prioritized technology investment portfolios that are directly traceable to architecture/mission needs through systems analysis. This may also involve the assessment and integration of technologies, either experimentally or computationally, into high fidelity system models that are representative of future aerospace systems to identify the most promising technologies for future systems. The system models may be from existing NASA programs/projects or newly created models for a specific assessment. Models of the appropriate level of sophistication must be used to assure sufficient discrimination between competing technologies. The performance of technology integration and assessment requires highly experienced, engineering and scientific expertise.

4.3 Engineering Design, Analysis, and Flight Hardware Development

LaRC has a rich heritage of engineering design and analysis, hardware development, fabrication, integration, testing, and operation of a broad range of aircraft and space systems. Flight hardware development can include mockups, wind tunnel models, test articles with varying degrees of system functionality, and the final flight units. This topic area requires engineering design, analysis, and hardware development, with a project oriented focus and in a schedule-driven, production environment. Work requirements in this topic will involve multiple considerations including, but not limited to, any combination of the following:

(i) Skill Mix – Task Order work requirements will involve a wide range of engineering disciplines with appropriate experience and skills, some of which may be very specialized, to perform all aspects of a given design and/or hardware development including, but not limited to:

- Aerodynamics, aerothermodynamics, and acoustics
- Trajectory development, optimization, and Monte Carlo analysis
- Mechanical engineering/design
- Linear and non-linear structural analysis/design (static and dynamic)
- Thermal analysis and thermal protection system design
- Fluid systems design/analysis
- Electrical/electronic systems design/analysis
- Control systems and avionics design/analysis
- Instrumentation and advanced sensor design/analysis
- Manufacturing/production, assembly, and integration methodologies

(ii) Phasing of Activities – Task orders may occur during any or all phases of the NASA program/project life-cycle, necessitating a wide range of development activities including, but not limited to:

- Systems analysis, system studies, and assessment of alternatives
- Requirements analysis and development
- Loads development
- Design, analysis, and development
- Production engineering (fabrication, assembly, integration)
- Functional and environmental testing
- Software system development and verification/validation
- Risk-management, safety assurance, reliability, quality, related analyses
- Mission operations, including disposition of assets

(iii) Reviews – Task Order work requirements may involve substantial contributions to the following NASA program/project life-cycle reviews including, but not limited to:

- Mission Concept Review
- Systems Requirements Review
- Conceptual Design Review
- Preliminary Design Review
- Critical Design Review
- Test/Flight/Mission Readiness Review
- Lessons Learned Review

4.4 Advanced Engineering Environments

LaRC maintains world-class leadership in development and utilization of advanced engineering environments and methods that enable and/or enhance a broad range of research, system analysis, and engineering design/analysis activities. Work requirements in this topic will include engineering, scientific, and software development, as required, to develop new or enhance existing tools and environments, including but not limited to:

(i) Computational Fluid Dynamics for aerodynamics and aerothermodynamics
(ii) Engineering codes for aerodynamics and aerothermodynamics
(iii) Design and analysis codes for engineering disciplines such as, but not limited to, mechanical, structural, acoustic, thermal, electrical/electronic, fluid systems, guidance/navigation/control, instrumentation/sensors, and propulsion
(iv) Simulation, including space and aircraft flight systems, both manned and un-manned
(v) Campaign analysis frameworks to facilitate integrated value, risk, cost, schedule, and performance assessments
(vi) Advanced visualization of computational and experimental results, including real-time simulations, and depiction of real-time mission data
(vii) Data measurement and collection tools for experimental testing in aerodynamics, aerothermodynamics, structures, aeroelasticity, and acoustics, both in ground and flight testing
(viii) Database development and management to support computational and experimental data storage, retrieval, and processing

4.5 Technical Management and Administration

LaRC is involved in programs and projects at many levels. LaRC leads some projects for NASA and supplies many technical and production services to projects led by other NASA Centers. In performance of mission objectives, these LaRC projects and activities require technical management and administrative work products. Work requirements in this topic area will involve management/administrative functions including, but not limited to:

(i) Project management support – Management analyses and assessments; cost modeling and estimating; development, maintenance, and reporting of schedules and budgets; reporting and trending of resources (funds and workforce) and project schedule milestones.
(ii) Technical documentation – Technical report writing and editing; technical illustration; technical proposal writing; configuration control; requirements development and tracking.
(iii) Administrative functions – Facilitation of technical or managerial team activities, including, but not limited to, scheduling of project activities; meeting and conference arrangements; planning/hosting of project life-cycle reviews; filing and maintenance of project documentation (paper and electronic).
(iv) Information technology (IT) – Development, enhancement, and maintenance of IT tools, including collaborative environments, databases, user interfaces, and user configurable reporting tools.
(v) Strategic planning support – Program and project planning support; organization and facilitation of workshops; support in identifying experts for Peer and Independent Reviews.