NASA Ames Research Center

PERFORMANCE WORK STATEMENT (PWS)

PROJECT ENGINEERING, MANUFACTURING, AND SCIENCE SERVICES (PEMSS)

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1.0 Introduction/Background

This Performance Work Statement (PWS) defines the requirements to support engineering and technology development in order to meet evolving NASA Ames Research Center mission objectives, along with interrelated mission functions of the Agency, other NASA Centers, and Government Agencies. The Project Engineering, Manufacturing, and Science Services (PEMSS) contract requirements will be executed on Task Orders (TOs) in accordance with NFS 1852.216-80 "Task Ordering Procedure" identified in Section H of the contract.

2.0 Scope

NASA Ames Research Center (ARC) develops and manages programs, projects, and technologies that support NASA's science, exploration, and aeronautics goals, with a focus on innovation. Currently Ames supports a variety of mission types and programs, including planetary science, astrophysics, space biosciences, astrobiology, heliophysics, and earth science missions; small satellite missions; technology development; aeronautics; and collaborative science programs. NASA ARC is a large campus environment consisting of approximately 125 facilities spread over an area of 2,000 acres. It is located on Moffett Field, CA, a property that includes ARC, Moffett Federal Airfield and the NASA Research Park (NRP). The campus includes general office space and state of the art research facilities including research laboratories, aerospace/aeronautics facilities (e.g., airfield/hangars, wind tunnels, arc jets, and simulators), computer laboratories, ballistic ranges, general testing facilities, lunar regolith testbed, fabrication facilities (e.g., machine shops, metal shops, and model shops), flight/mission operations facilities, motor pool, test chambers, and storage facilities.

ARC Website: https://www.nasa.gov/ames/

PEMSS will provide specialized science, and engineering services supporting these activities and NASA's mission. Work will include cooperative activities with other contractors, NASA Centers, and Federal Agencies.

The requirements in this PWS will provide program, science, engineering, operations and project management support for such efforts as biosciences flight development projects (e.g., mission implementation, instrument development, and technology advancement efforts), collaborative science programs (e.g., astrobiology, virtual institutes), spaceflight, ground based systems, facility and mission support.

The Contractor must have the responsibility to allocate resources as requirements change and have access to employees with the necessary capabilities to perform the required work. The requirements and capabilities projected below are provided as the parameters of the overall effort that may be required and will be specified, in work packages or task orders to accommodate emerging mission and customer requirements. This contract requires the Contractor to provide management, personnel, equipment, materials, and facilities, not otherwise provided by the Government, to meet the requirements described in this PWS.

The majority of the work will be performed on-site at NASA Ames with occasional support

to be provided at other NASA Centers, other Government agencies, principal investigator laboratories, other countries, and at such other locations as directed by the Contracting Officer.

3.0 Contract Management

The Contractor shall provide an overall effective, efficient, and responsive management and administrative function to ensure the proper resources are available and allocated, adequate reports and documentation are prepared, and the overall work environment supports the PWS requirements. The Contractor shall provide an organizational structure with clear lines of authority and clearly identified Government interfaces. The Contractor shall be responsible for ensuring that all contractor and subcontractor personnel engaged in performance of this PWS have appropriate qualifications, knowledge, clearances, certifications, and are free from conflicts of interest, to perform work in accordance with the PWS requirements.

The Contractor shall maintain a Facility Clearance at the Top-Secret level with no safeguarding required in accordance with Exhibit F – Contract Security Classification Specification (DD254). The Contractor will access classified information at a Government facility to be identified on the Department of Defense Contract Security Classification Specification, DD Form 254.

The Contractor shall comply with all U.S. export control laws and regulations including, but not limited to, the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in performance of this contract. In the absence of available license exemptions/exceptions, the Contractor shall be responsible for obtaining the appropriate license or other approvals, if required, for exports of hardware, technical data, and software, or for the provisions of technical assistance. The Contractor shall screen individuals at appropriate times to ensure ITAR compliance and shall insert this requirement in all subcontracts that may involve ITAR or EAR controlled information.

3.1 General

3.1.1 Contractor-Furnished Equipment

The Contractor shall furnish shop coats or coveralls and provide laundry service for all work elements associated with Code RM shops. The Contractor shall also furnish all required Personal Protective Equipment (PPE), with the exception of breathing respirators, in accordance with the Ames Safety and Health Manual (APR 8715.1). All PPE provided shall comply with applicable safety standards and support safe execution of work activities across supported operations.

3.2 Technical Requirements Management

The Contractor shall provide technical management functions and processes to ensure that all engineering design, development, and test for NASA programs as authorized by

NASA are accomplished in accordance with the highest engineering standards. The Contractor shall implement technical management processes commensurate to the technical product or service being provided in accordance with contract provisions and the relative risks to flight program success. The Contractor shall provide technical discipline expertise, independent assessment, engineering analysis, technical insight, technology assessment and development, and programmatic support, as required to assure high degree of technical accuracy and quality. The Contractor shall interface with but remain distinctly independent from all other Contractors supporting NASA programs.

3.3 Foreign Travel Management

Foreign Travel and supplemental requirements can be found in attachment J1a – Requirements Statements List.

3.4 Management Meetings

The Contractor shall participate in periodic meetings with the CO to discuss contract performance issues, process improvements, risks and related issues, corrective actions, recovery plans, and other details of contract operations. These informal meetings will be attended by the CO, COR, and Technical Point of Contacts (TPOCs).

The Contractor shall participate in reviews with the CO to discuss cost planning, phasing, and performance of the overall progress of the Contractor, subcontractors and vendors as required by the CO. These reviews may include both formal and informal discussions with multiple customers requiring multiple products/reports, sometimes due concurrently.

Contractor personnel shall participate in semi-annual meetings with CO, COR, and discipline representatives to discuss SMIRP requirements.

Contractor personnel shall maintain frequent communications with the Government regarding technical challenges, accomplishments, findings, problems, risks, corrective actions, progress, and other details of contract operations. The Contractor shall participate in meetings including, but not limited to, program/project status meetings and teleconferences, team planning meetings, technical interchange meetings, and conferences.

3.5 Training

The Contractor shall provide specialized training to Government personnel regarding products including, but not limited to, tools, methods, procedures, and techniques developed or implemented by the Contractor.

3.6 Software Management

The Contractor shall develop and maintain a Software Management Plan (SMP), including supporting documents, in accordance with NPR 7150.2, NASA Software Engineering Requirements depending on the software class, identified as follows:

Class A: Human-rated Space Software Systems

Class B: Non-Human Space Rated Software Systems or Large-Scale Aeronautics Vehicles

Class C: Mission Support Software or Aeronautics Vehicles, or Major Engineering / Research Facility Software

Class D: Basic Science/Engineering Design and Research and Technology Software

Class E: Small Light Weight Design Concept and Research Technology Software

Based on software class (identified in NPR 7150.2) additional requirements, software products, and documentation contents will be specified by NASA in TDNs or TOs.

The Contractor shall manage and track data delivery requirements to differentiate between open-source, unlimited rights, and restricted computer software/limited rights data. The Contractor shall proactively notify the CO and COR of any proposed delivery of restricted computer software or limited rights data in accordance with FAR 52.227-14.

3.6.1 Use of Off-the-shelf, Reused, or Open-source Software

The Contractor shall notify the COR whether off-the-shelf, reused, or open-source software will be included in code developed for the project and to obtain all necessary licenses to permit use of such software. The Contractor shall satisfy the following conditions when a Commercial, Government, Modified Off-the-Shelf (COTS, GOTS, MOTS), open source, or reused software component is acquired or used:

- The requirements to be met by the software component are identified
- The software component includes documentation to fulfill its intended purpose (e.g., usage instructions)
- Proprietary rights, usage rights, ownership, warranty, licensing rights, and transfer rights have been addressed to permit use of the software
- Future support for the software product is planned and adequate for project needs
- The software component is verified and validated to the same level required to accept a similar developed software component for its intended use
- The contractor has a plan to perform periodic assessments of vendor reported defects to ensure the defects do not impact the selected software components

For any new off-the-shelf or open-source software to be installed on NASA systems, the contractor shall submit an authorization request to IT Acquisition Management (ITAM); only software with approved authorization can be installed on NASA systems.

3.6.2 Automatic Generation of Software Source Code

The Contractor shall define the approach to the automatic generation of software source code including but not limited to:

- Validation and verification of auto-generation tools
- Configuration management of the auto-generation tools and associated data
- Identification of the allowable scope for the use of auto-generated software

- Verification and validation of auto-generated source code
- Monitoring the actual use of auto-generated source code compared to the planned use
- Policies and procedures for making manual changes to auto-generated source code
- Configuration management of the input to the auto-generation tool, the output of the auto- generation tool, and modifications made to the output of the auto-generation tools

3.6.3 Software Cybersecurity

The contractor shall consult with a designated NASA Information System Security Official (ISSO) to perform a software cybersecurity assessment on the software components per the Agency security policies and the project requirements, including risks posed by the use of COTS, GOTS, MOTS, OSS, or reused software components.

3.6.4 IT Security Control

a. **Place holder for IT language**

3.6.5 Use of Artificial Intelligence (AI) During Contract Performance

a. Place holder for PIC 25-03A

4.0 Technical Requirements

Services shall be required in one or more of the areas described in the scope below for any given task order. Services within the scope of this PWS and as specified in TOs shall include, but not be limited to, the specific services delineated in the following sections:

4.1 Support of NASA Programs and Projects

The Contractor shall perform Project Management for all requirements defined in this PWS in accordance with NASA Procedural Requirements (i.e., NPD 7120.4E, NPR 7120.8, and NPR 8820.2G, as applicable) unless otherwise specified in work package requirements. Project management support requirements include: coordinating all resources within a functional area necessary to meet the technical, schedule, and budget requirements, as well as support for planning and development of ARC proposals and mission concepts, work breakdown structure development, project cost/schedule estimation and tracking. Requirements also include use of Microsoft (MS) Project software and Milestone Pro, support for project requirements development and management, communication with customers, coordination with the NASA ARC Safety and Mission Assurance (SMA) Directorate, configuration management, quality assurance, and safety/risk management.

All work shall be performed in a manner that complies with environmental regulations and NASA policy, including, APR 8500.1, ARC Environmental Procedural Requirements. This

includes, but is not limited to, protecting the environment through the ongoing planning, implementation, integration and management control. With respect to hazardous materials, observe and adhere to requirements for handling, storage, and disposal of hazardous, toxic, and combustible supplies, materials, and waste. At least 14 days prior to bringing additional hazardous materials onsite, notify EMD for review and approval. Only bring and use hazardous materials onsite that EMD has approved.

The Contractor shall participate in project team meetings and reviews with a level of engagement and support consistent with their role in the project. Some examples are requirements reviews, conceptual design reviews, system definition reviews, preliminary design reviews, peer reviews, critical design reviews, test reviews, operational reviews, system safety reviews, airworthiness review boards, and flight readiness reviews as specified in customer task, subtask, and work package requirements. The frequency of these meetings will be specified in the work packages and will be based on the necessary communications and understanding amongst the project staff.

The Contractor shall provide support to government staff in the development, monitoring, and collection of performance metrics used to evaluate system and team performance against goals, requirements, and expectations. This support includes assistance throughout the full lifecycle of performance measurement and assessment activities to ensure accurate tracking and reporting of program and project progress.

The Contractor shall provide versatile, adaptable, multi-functional project teams capable of supporting end-to-end activities spanning Pre-Phase A through Phases E and F for a range of spaceflight projects. These teams shall be able to adjust to varying project scopes and requirements and provide sustained technical and administrative support throughout all phases.

The Contractor shall support development of full life-cycle project documentation as required by NPR 7120.5. This includes preparation, maintenance, and integration of documentation necessary to meet NASA project management standards and lifecycle milestones.

The Contractor shall implement and ensure that contractor personnel can perform all processes and procedures required for the design, manufacture, testing, operations, maintenance, and refurbishment of spaceflight hardware. Personnel must be able to execute all required activities in alignment with applicable NASA processes, constraints, and mission requirements.

The Contractor shall also provide proper training and instruction for contractor personnel regarding flight hardware development and integration processes, including all on-site ARC flight protocols, procedures, and work instructions. Training shall ensure that personnel adhere to required technical, safety, and procedural standards for the development and handling of spaceflight hardware.

4.1.1 *Mission Design Center (MDC)*

The NASA ARC's MDC conducts early-stage concept development and technology maturation supporting the Center's space and aircraft missions, and critical research

facilities proposals. The Contractor shall support NASA/ARC's development of mission concepts and architectures, proposal development with associated cost and schedule estimation, design of spacecraft busses in support of instruments, and design of instruments in support of NASA/ARC's science, technology, and exploration objectives. The Contractor shall provide technical Subject Matter Experts (SMEs) and licensed professionals, as required in specific work packages, to support early-stage concept development and technology maturation for ARC's MDC-generated aerospace and aircraft missions, and critical research facilities proposals. The Contractor shall perform scheduled as well as rapid-response design cycles to support the development of initial mission and research facility concepts into proposal-ready, fully supportable technical packages.

4.1.1.1 Design Tools Development

The MDC staff use, develop and customize design tools supporting the full mission, including, for example, orbit/trajectory design, thermal and electrical analyses, avionics and guidance, navigation and control design, development of operations concepts, and costing. The Contractor therefore shall be capable in the use of standard Government-supplied design tools including STK, Matlab, Simulink, GMAT, Microsoft Office suite, Confluence, Jira, Thermal Desktop, and CREO, as well as the languages (C, C++, Python) toolchains (Gnu, Microsoft) and development environments (Git, Eclipse, Microsoft Visual Studio).

4.1.1.2 Proposal Development

A key role for the MDC is the creation, leadership and support of proposals for new work performed by Ames. These may be in response to NASA or other agency solicitations or developed by ARC for direct submission to NASA programs or other opportunities. The Contractor shall support ARC proposal development in roles including proposal development lead; volume manager responsible for coordinating the written content of a proposal section; technical or scientific content lead; or in a variety of other lead and supporting roles as appropriate to the proposal. The Contractor shall support Ames proposal development by providing technical input, as well as technical writing, editorial, and graphics support.

4.1.2 Science Programmatic Support

The Contractor shall provide comprehensive program and project management support to oversee, execute, and evaluate complex scientific, technical, and engineering initiatives. This encompasses full life-cycle project management to facilitate coordination among decentralized research teams, manage program resources, and oversee technical portfolio execution across division objectives and strategic partnerships. Programs such as Solar System Exploration Research Virtual Institute (SSERVI), Space Biology Project Office, and Astrobiology Institute.

4.1.2.1 Strategic Program Integration & Management

4.1.2.1.1 Program Oversight & Performance Evaluation

Provide strategic oversight of distinct scientific and technical portfolios. Design and implement

program evaluation frameworks, manage project funds, track progress against agency milestones, and utilize appropriate metrics to measure and report technical effectiveness into agency-wide databases.

4.1.2.1.2 Scientific Working Group & Event Management

Coordinate and lead specialized working groups, executive councils, and large-scale scientific conferences. Facilitate complex collaborations across multiple disciplines, managing the technical execution, production, and project management infrastructure required for these efforts.

4.1.2.1.3 Strategic Partnerships & Complex Initiatives

Manage and cultivate strategic partnerships with internal and external organizations. Provide technical leadership and project management for robust research initiatives, including citizen science programs, integrating these efforts with broader agency research objectives.

4.1.2.2Science Project Support & Technical Leadership

4.1.2.2.1 Scientific Portfolio & Subject Matter Expertise

Provide targeted scientific and technical subject matter expertise to assist Program Scientists and Division leadership. Support the execution of technical objectives, research efforts, and the adaptation of highly technical scientific data into usable platforms.

4.1.2.2.2 Exploration Science & Data Visualization

Provide technical support, strategic planning, and leadership for advanced scientific visualization and planetary mapping projects, coordinating directly with agency leadership and partner research centers.

4.1.2.2.3 Scientific Asset & Resource Management

Oversee the technical tracking, handling protocols, and specialized training programs required for the safe utilization and distribution of scientific assets and planetary materials to research and educational partners.

4.1.2.2.4 Scientific Content Development & Strategic Communications

Produce and manage high-level scientific data products, technical publications, graphics, and reports (e.g., annual reports, newsletters). Synthesize complex research into scientifically accurate content for digital platforms, websites, interactive applications, and executive presentations. Develop strategic communications to disseminate division research, publicize scientific discoveries, and connect researchers with external stakeholders.

4.1.2.3 Engineering and Technical Systems Management

4.1.2.3.1 Engineering Initiatives & Facility Safety Management

Provide technical evaluation, subject matter expertise, and project management for advanced

aerospace and robotics initiatives (e.g., systems engineering competitions, robotics evaluation). Develop, review, and maintain comprehensive technical documentation and safety plans for specialized engineering test facilities and test beds.

4.1.2.3.2 Digital Systems & Platform Management

Oversee the technical development, architecture, enhancement, and maintenance of web-based applications, technical databases, and digital infrastructure required to support program operations and data dissemination.

4.1.2.3.3 Technical Infrastructure & Systems Integration

Manage the technical, hardware, and engineering requirements for distributed scientific teams and major events. This includes coordinating specialized audiovisual systems, interactive digital presentation boards, and virtual engagement networks to support high-level technical seminars and data reviews.

4.1.2.4 Virtual Communications and Collaboration Support

The contractor shall provide expertise and knowledge of the state of the art in collaboration technologies, periodically assess developments with respect to new tools and technologies, and advise NASA on their integration into the Center's, and particularly, the virtual institutes' tool-kits.

Research and develop 3D immersive environment tools for global collaboration and participation.

Enable collaborative science and technology development, science over distance, virtual field trips, and virtual world systems. Provide expertise in the social and organizational aspects of collaboration. Provide comprehensive support for Center and institute meetings, technology interchange meetings, and conferences, including virtual and online (video conferencing) meetings.

4.1.3 Project Records and Documents Support

The contractor shall provide records and document management support, and records archiving support for supported programs and projects and the Engineering Directorate and its Divisions. The support will include configuring and maintaining electronic file storage systems according to NASA records management and records archiving standards. The contractor shall support engineering and directorate information collaboration, and configuration management tools and processes, and engineering quality information systems and processes. The support needs to closely align with the projects and engineers producing the content, the engineering database systems, and the tools utilized by the Programs and Projects and Engineering Directorates.

4.1.4 Data Document Management and Archival Support

As authorized by a fully executed Task Order, the Contractor shall establish and maintain project operational and documentation databases, including those used for requirement traceability. The Contractor shall collect, maintain, analyze, and disseminate data from

operational scientific missions and shall provide data-analysis and archival services in support of these efforts. Additional responsibilities include providing integration of information and data across systems and organizations and providing mapping of areas of expertise and capabilities to one another and to proposal development activities.

4.1.5 Technical Writing

The Contractor shall develop, maintain and deliver, upon request, technical and business documentation, such as the written content of proposal sections, technical papers, manuals, engineering and business reports, and presentation packages. The Contractor shall develop and maintain documentation in accordance with requirements described in the work package.

4.1.6 Configuration Management

The Contractor shall follow the NASA procedures for configuration management and control of documentation generated during the life of the work element as required by applicable NASA Procedural Requirements (NPR), Ames Management System (AMS) directives, and the customer. The Contractor shall also participate on ARC Change Control Boards (CCBs) as needed to satisfy contract requirements.

4.1.7 Proposal and Solicitation Support

The Contractor shall support ARC's efforts to develop and improve proposal processes and proposal submission outcomes for both NASA and non-NASA opportunities. This can include recommendations for alternative or modified technical approaches and concepts. The contractor shall provide technical editing, graphics and document administration in support of ARC proposals. The contractor shall also support the development of a NASA dashboard tool that provides a clear and informative overview of all competitive proposals for which NASA ARC qualifies. The tool will include actual and expected announcements of opportunity (AO), current and open AOs with details (e.g., status, organization leads, Principal Investigators (PIs), and funding levels) and closed AOs with details (e.g., status and expected award announcements). The Contractor shall provide database solutions and proposal development support that contains information on partnership development and technology transfer. The contractor shall also identify and implement solutions and tools to store, access, and characterize proposal data, and provide this information to NASA as specified in the work package or task order.

The Contractor shall support efforts to develop and improve Ames proposal processes and proposal submission outcomes for both NASA and non-NASA opportunities. This includes assisting with refining workflows, identifying bottlenecks, improving proposal quality, and enhancing the overall competitiveness of Ames submissions. The Contractor shall support the development of a dashboard tool that provides a clear and informative overview of all competitive proposals available for Ames to submit. This tool shall include actual and expected announcements of opportunity (AOs), details on current and open AOs including their status, organization leads, principal investigators, funding levels, and related data, as well as information on closed AOs such as their status and expected award announcements.

The Contractor shall provide database solutions and proposal development support containing information related to partnership development and technology transfer. This includes identifying solutions and tools to store, access, and characterize proposal data, ensuring that proposal-related information is organized, searchable, and usable for strategic planning and decision-making.

The Contractor shall prepare documentation in support of Ames-managed solicitations such as NASA research proposals. The Contractor shall support the development and evaluation of proposals submitted to Ames-managed opportunities by assisting with documentation, compliance reviews, and administrative preparation. The Contractor shall also support the peer-review process by preparing science and technical summary packages that may include background information, scientific rationale and relevance, proposer qualifications, flight or technical experience, results, and references.

4.1.7.1 Thermal Systems Design and Analysis

The Contractor shall perform the work by providing expertise in all areas of thermal systems design and analysis. The contractor shall apply this expertise when developing thermal system architectures through use of passive and active thermal control techniques. The work requires the application of various Government provided thermal analysis programs, Finite Element Modeling and Analysis using MSC/PATRAN, MSC/NASTRAN, Creo Simulate and Thermal Desktop, and the application of experimental methods and closed-form solutions. Thermal design and analysis includes the assessment of the exchange of thermal energy between physical systems, and the evaluation of structures and systems for heat transfer, including contributions from conduction, convection and thermal radiation. Application includes the study and analysis of heat transfer through various materials comprising spacecraft, aircraft and ground systems. This includes various mechanical structural designs supporting Thermal Protection Systems (TPS), including ablative TPS systems, for spacecraft.

4.1.7.2 Fluid Mechanics Systems Design and Analysis

The Contractor shall perform the work by providing expertise in all areas of fluid mechanics systems design and analysis. The contractor shall apply this expertise when developing fluid mechanics systems for experimental devices installed on aircraft external surfaces or in wind tunnel airstreams. Tasks may include design and analysis of systems, components and instrumentation for internal fluid flow through pipes, ducts, channels, and conduits, to determine precise flow parameters. The work requires a fundamental understanding of aerodynamics and fluid dynamic analysis (e.g., lift, drag, and determination of boundary layer thickness) and computational fluid dynamic (CFD) modeling. The contractor may be required to use Government-provided modeling software, including WaterCAD. The Contractor shall also provide microfluidics fluid mechanics expertise to meet requirements for design, development, assembly, integration, prototyping and testing of microfluidics systems used within spacecraft or payloads systems.

This can include micro-fluidics cards, manifold, pumps, valves, media storage and waste bags. Microfluidics systems development will focus on support for long duration missions in microgravity and other extreme environments. The primary application area for the microfluidics will be biology or astrobiology experiments in microgravity, so biocompatibility will also be a significant factor in the engineering of these systems.

4.1.7.3 Cryogenic Systems Design and Analysis

The Contractor shall perform the work by providing expertise in all areas of cryogenic systems design and analysis. The contractor shall apply this expertise when developing, designing and modeling cryogenic systems – including multi-phase cryogenic fluid modeling, procuring and/or fabricating system equipment, planning and implementing system testing, acquiring and reporting test results, and the evaluation and maintenance of cryogenic systems. Tasks includes the operation and maintenance of cryogenics laboratory facilities at Ames, including instrument calibration and maintenance, vacuum system maintenance, experiment troubleshooting, hazardous materials control, and safety assurance.

4.1.7.4 Electrical/Electronics

The Contractor shall perform the work by providing engineering and technician expertise in all areas of electrical/electronics engineering, including the ability to design and develop instrumentation, analog and digital sensors, embedded systems, small and large (facility) power systems, security systems, data acquisition systems, and communication systems. The Contractor shall minimize power consumption and physical size of electrical systems, unless otherwise specified in work package requirements. The Contractor shall use Government-provided Altium, Orcad/Cadence and LabView for electrical schematic/PCB design simulation and user interface. The Contractor shall meet NASA's requirements (NASA-HDBK-8739.21) for electrostatic discharge control. Applications include avionics in support of small spacecraft and rockets for secondary payloads. These systems utilize a combination of COTS and custom-designed hardware/software/firmware.

4.1.7.5 Sensors and Instrumentation Development

The Contractor shall perform the work by providing all necessary expertise for sensors and instrumentation development. The contractor shall apply this expertise when developing designs for sensor and instrumentation systems including airborne and spaceborne atmospheric chemistry, atmospheric physics, remote sensing, and astronomy instruments; cryogenics systems and sensors; biomedical, chemical, and bio-telemetry sensors; and laser and optics development. The Contractor shall conduct trade studies and industry searches as specified in work package requirements. The Contractor shall develop custom analog and digital circuitry emphasizing modularity and high margin-of-safety as specified in work package requirements.

4.1.7.5.1 Embedded Computational Systems Development

The Contractor shall perform the work by providing all necessary expertise for embedded computational systems development. The contractor shall apply this expertise when developing designs for embedded systems include custom software and firmware development, custom hardware, data compression and storage development, electronics packaging, cable design and researching new applicable technologies.

Embedded systems are used to control instrumentation, payloads, and/or hardware, and collect research data. Embedded systems can also include Command/Data Handling

(C&DH) for an aircraft or spacecraft and its payloads.

4.1.7.5.2 Power Systems Design and Development

The Contractor shall perform the work by providing all necessary expertise for power systems design and development. The contractor shall apply this expertise when developing designs for power systems that include power distribution, generation (e.g., solar panels) and management systems and custom hardware/software/firmware development, commercial power supply selection for a given system, and system designs with minimal conducted and/or radiated Electromagnetic Interference (EMI). This includes the development of battery packs and miniaturized batteries. Power System design and development support also applies to ARC Electrical Distribution Systems, Protective Relay System, and ARC Power Monitoring System. This includes designing, providing configuration management of electrical system database, files and drawings, updating existing Electrical Distribution Systems, and implementing electrical protective relay system upgrades for the NASA Ames Electrical Distribution System. The work requires knowledge and use of the Government-provided SKM software and managing the SKM system model and database. The government will furnish specialized relay testing equipment, dedicated software and all other items necessary to conduct required tests and make all required relay setting adjustments. Some tasks may require engineering field support.

4.1.7.5.3 Control Systems Design and Development

The Contractor shall perform the work by providing all necessary expertise for control systems design and development. The contractor shall apply this expertise when designing or developing control systems that are utilized by NASA in aircraft and spacecraft Guidance, Navigation, and Control (GN&C), science payloads, instruments (ground, airborne, and space), arc jet facility, wind tunnels systems, model supports, motion simulators, centrifuges, autonomous robotic controls systems, environmental control systems, ARC facility electrical power and fire alarm systems, the ARC Facility Management Control System (FMCS), the Ames Power Monitoring System (APMS), and process control systems. The Contractor shall meet NASA's requirements for electrical safety and electrostatic discharge control as defined in NASA Procedural Requirements (NPRs), Ames Management System (AMS) directives, NASA-HDBK-8739.21, and shall be proficient in using the Government-provided MATLAB and LabView. For facility control system support, the contractor shall develop piping and instrumentation diagrams (P&IDs). Examples of applications for required control system support are described below.

4.1.7.5.4 High-Performance Servo Systems Applications

The Contractor shall perform the work by providing the necessary expertise for high-performance servo system design and development. Aircraft and Spacecraft control systems are generally high-performance servo systems, such as 1) gimbaled axes positioning control system which must address relatively high stiffness, pressure disturbances, and vibration; 2) gyro-inertial tracking systems with accuracy in arc-seconds; and 3) precision temperature control systems. Servo systems can be elements of C&DH subsystems, Attitude Determination and Control Systems (ADCS), and GN&C. The Contractor shall meet requirements for applicable standards and certification processes for flight-quality hardware as specified in the customer tasks, subtasks, and work packages. System design and testing will require servo analysis and computer

simulation. The Contractor shall provide pre-flight ground support and in-flight validation of control system performance.

4.1.7.5.5 Wind Tunnels Applications

The Contractor shall perform the work by providing the necessary expertise for wind tunnel control system design and development. Wind tunnel control systems are used to set flow conditions (dynamic pressure ("Q"), Mach and Reynolds numbers) via pressure, drive RPM, nozzle/flexwall, and temperature control systems, and to control the attitude and position of the test model. System components include large high-power electric motors, blowers, pumps, large valves, and compressors. Contractor tasks may include the design and development of distributed control systems that use programmable logic controllers for control and operation for these applications.

4.1.7.5.6 Motion Simulators and Centrifuges Applications

The Contractor shall perform the work by providing the necessary expertise for motion simulator and centrifuge control system design and development. Motion simulator and centrifuge systems are motion-based power-driven control systems. The Contractor shall ensure smoothness of operation, high reliability and man-rating, for long or short-term operation. The Contractor shall address issues such as cross-coupling and structural resonance of large-payload, multiple-degrees-of- freedom motion systems. These control systems involve velocity and acceleration controls of motor drives and high pressure pneumatic/hydraulic actuators.

4.1.7.5.7 Autonomous Robotic Systems Applications

The Contractor shall perform the work by providing the necessary expertise for autonomous robotic control systems design and development to explore new concepts utilizing new technology, customized prototype design, subminiature control hardware, and microprocessor-based control systems and embedded controllers. Most systems utilize embedded software.

4.1.7.5.8 Environmental Control Systems Applications

The contractor shall perform the work by providing the necessary expertise for environmental control systems design and development to maintain control parameters for stable environmental conditions, such as temperature and humidity for airborne instruments, wind tunnels, facility heating, ventilation & air conditioning (HVAC) systems, and life science experiments flying aboard spacecraft.

4.1.7.5.9 Micro-Propulsion Systems Applications

The Contractor shall perform the work by providing the necessary expertise for micro-propulsion control systems design and development. This work includes developing a micro-propulsion system suitable for attitude control of small-scale satellite systems. Support activities include design, development and testing of prototype thrusters and power supplies.

4.1.7.5.10 Ames Power Monitoring System (APMS) Applications

The Contractor shall perform the work by providing the engineering expertise to support

the continuous design improvements that are necessary to ensure the Ames Power Monitoring System (APMS) will have as high of a system availability as possible. The APMS is a network of power meters located throughout the Center, connected to a centrally located server, where system health status and power consumption is measured 24/7. ARC benefits from this system by monitoring trends, verifying power consumption, managing and scheduling power usage, and assisting cost control with the utility provider. Task will include monitoring operations and maintenance for troubleshooting and correcting software and hardware issues, to facilitate system upgrades, ensuring Center Local Area Network (LAN) upgrade compatibility with APMS, and meter additions and programming.

4.1.7.5.11 Data Acquisition Systems Design and Development

The Contractor shall perform the work by providing all necessary expertise for data acquisition systems design and development. The contractor shall apply this expertise when designing or developing data acquisition systems, which can include selecting commercial sensors and data acquisition equipment, developing needed custom software and hardware, and performing data collection for analysis. Data acquisition systems are used to collect large amounts of data from research facilities, models or experiments.

4.1.7.5.12 Communication Systems Design and Development

The Contractor shall perform the work by providing all necessary expertise for communication systems design and development. The contractor shall apply this expertise when designing or developing communication systems, which can include transmitters and receivers, serial communications, satellite communications, spacecraft communications, information systems, Ethernet communications, radio communications, Internet interfaces (including wireless), and custom hardware/software development. Support also includes any required licensing for the communication systems.

4.1.7.5.13 Software and Firmware Systems Design and Development

The Contractor shall perform the work by providing all necessary expertise for software and firmware systems design and development. The contractor shall apply this expertise when designing or developing system software and firmware, test software and firmware, Internet products, custom or off-the-shelf databases, data analysis, design tools, project related IT structure, upgrades to existing software/firmware and developing research models for conceptual designs. For aircraft and spacecraft, the work includes supporting the development of firmware for flight dynamics systems including C&DH systems, Attitude Determination and Control Systems (ADCS), GN&C, and communication systems. Development tools require the use of standard programming languages along with Simulink, Matlab, ATK and other programming instruction sets, as defined in work packages, compatible with government provided software and firmware.

4.1.7.6 Chemical, Biological, Biomedical and Radioactive Systems

The Contractor shall perform the work by providing all required expertise in the areas of chemical, biological, biomedical, and radioactive systems. This includes the ability to design, fabricate, test and inspect systems and subsystem components that contain, transport, manipulate, process, and investigate, potentially hazardous chemical, biological, biomedical, and/or radioactive materials in support of NASA space and life

science research. Example projects include the development of chemistry protocols for the isolation of RNA from blood, plant, or mammalian cells for ISS experiments, and evaluation of yeast as a radiation dosimeter in small spacecraft applications. The contractor shall ensure work is compliant with all applicable safety and environmental regulatory requirements governing the use of these materials and operations of these systems.

4.1.8 Assembly, Integration, and Test (AI&T)

The Contractor shall lead or support project efforts in the areas of Assembly, Integration, and Test (AI&T). AI&T activities will be in support of a variety of project types including both spaceflight systems and ground systems. Contractor AI&T tasks may include support for prototypes and engineering development units, qualification units, and/or flight units. The work encompasses touch labor for assembly and integration and technicians for instrumenting hardware, conducting tests, and data reduction. Integration and test activities culminate in Verification and Validation testing of systems in readiness for operations review gates.

4.1.9 Operations, Sustainment, and Closeout

The Contractor shall lead or support project efforts in the areas of operations, sustainment, and closeout. Operations includes the task to conduct the prime mission of the project or system. This includes concept of operations development, operations planning, operations requirements specification, and execution of the operations phase of small satellites flights, spaceflight payloads, or research facilities using either in-house mission operations centers, partner's operations centers, or contract operations facilities. Operations support can also include providing launch support services. Sustainment tasks include maintenance of the system with appropriate data logs, data reduction and analysis, evaluation reports, and preparation for deactivation or decommissioning. Closeout tasks include the disposition the system or facility as required, documenting lessons learned, and archiving all documents and data in the closeout phase.

4.1.10 Project Technical Review and Compliance

ARC's Facilities Engineering Branch (Code JCE) conducts ARC Architectural and Engineering support for Building and R&D Facilities Design and Construction Projects. The Contractor shall perform engineering reviews and inspections related to Code Compliance for designs developed, for building construction projects. This may also include safety, environmental, and performance compliance inspections for research facility systems involving complex high- energy electrical, mechanical, pressure, thermal and/or chemical components.

4.1.11 Engineering Support and Support for Technology Development Responsibilities

The Contractor shall support laboratory and prototype hardware development and demonstration efforts from concept through operations. This includes assisting with the design, maturation, and operational readiness of hardware throughout all phases of development and supporting activities required to bring hardware concepts into functional

systems. In addition, the Contractor shall support development of full system design and architecture in accordance with NASA NPR 7123, ensuring that system-level products and architectural frameworks comply with agency standards.

The Contractor shall support system and hardware assembly and test activities, contributing to integration, verification, and validation processes. This includes working with engineering teams to assemble components, conduct system-level testing, and document results in support of program milestones. The Contractor shall also support the development of innovative technologies in areas such as advanced manufacturing, life support systems, space biotechnology, operating systems, payloads, sensors, micro- and small-satellites, and system architectures. Support shall extend to Fellows conducting research into innovative technologies, particularly those participating in NASA Space Technology Research Fellowship activities.

The Contractor shall support the overall planning, formulation, and implementation of technology projects, tasks, and related efforts. This includes assisting with requirements analysis, technology assessments, monitoring emerging technologies, and conducting trade studies. The Contractor shall contribute to integrating these assessments into optimal technology planning and investment strategies and into hardware and technology development projects.

The Contractor shall also support special studies that lead to the development of innovative approaches to technology development and collaborations. These studies may involve identifying emerging technical opportunities, evaluating new methods, or exploring alternative concepts to advance future technology capabilities.

4.1.12 Flight Project and Mission Operations Information Technology Support

The Contractor shall perform the work by providing all required expertise related to the technical areas of this section and associated work and apply this expertise when performing the work.

ARC leads and/or supports numerous science and technology space or airborne flight projects, ranging from concept definition, through system and component design and development, to mission operations. At every phase of these projects, mission-critical information technology support is required to ensure customer satisfaction and mission success.

ARC's Multi-Mission Operations Center (MMOC) supports flight and science operations for selected NASA spaceflight missions. The MMOC is composed of the facilities, networks, Information Technology (IT) equipment, software, cybersecurity, and support services needed by flight projects at ARC to effectively and efficiently perform all mission functions, including planning, scheduling, command, telemetry processing, and science analysis. The MMOC facilities and data systems are Federal Information Security Management Act (FISMA)-compliant and require renewed authority to operate annually. The MMOC has mission operations facilities in two buildings at ARC, N-240 and N-244, an arrangement that provides geographic diversity and resiliency in the event of a facility disaster. The facilities include two general-purpose Mission Operations Centers plus project-specific support areas in satellite buildings. The current capacity of the MMOC ranges up to 10 simultaneous missions, dependent upon mission size and complexity, and resources exist to support future expansion.

The Mission Design Division, Engineering Systems Division, and Applied Manufacturing Division jointly participate in developing and implementing flight projects. These Divisions have facilities in buildings N202, N212, N213, N220, N240, and N244, and includes facilities for spacecraft, systems, instrument and payload design, development, manufacturing, integration, and testing, including cleanrooms, machine shops, electrostatic discharge (ESD) controlled environments, and avionics labs. The distributed workforce across the Center requires a highly responsive Contractor cognizant of the unique requirements of the flight projects environment.

The Contractor shall perform the work described, by providing space flight mission support for the MMOC including system administration, cybersecurity, and maintenance of all enterprise and mission-specific IT equipment (workstations, servers and virtual machines running Linux, Windows and MacOS operation systems) and databases (including Oracle and MySQL). The Contractor shall provide expert level network engineering to maintain and evolve the Ames Mission Network and to define and activate connections to the spacecraft, and to mission partners at other NASA centers, in industry and in academia. The Contractor shall provide expert ISSO and ISSE staffing to perform all tasks required for MMOC to meet and exceed all applicable cybersecurity requirements.

The Contractor shall deploy, configure and maintain all mission software tools that support all aspects of mission support, including but not limited to command and telemetry, data processing capabilities for telemetry and science data handling, storage, distribution and archiving including tools such as GFSC's Advanced Spacecraft Integration and System Test (ASIST) Software and Integrated Test and Operations System (ITOS), and OpenMCT among others. The Contractor shall support all enterprise software for MMOC customers, such as Atlassian's Confluence and Jira, SharePoint, Nagios, OpenStack, VMWare, IBM SKLM, and source code control software (e.g., VSCode, svn, git), among others, and be able to retain skilled labor to support any enterprise or mission software used.

Highly specialized information technology requirements include support for tools necessary for the analysis, design, development, and testing of flight software and hardware; support for mission-critical enterprise and open-source software; and support for project-specific and enterprise systems management. These requirements encompass System Security Plan (SSP) development and implementation, Linux operating system and tools installation, configuration, and maintenance, patch compliance, and micro-controller and embedded system configuration and toolchain support for platforms such as Arduino, Beaglebone, and Raspberry Pi. They also include instantiation, maintenance, and support of source control repositories such as Git and Subversion, as well as collaboration and issue-tracking systems including Confluence and Jira.

The Contractor shall also support the instantiation, maintenance, and operation of virtualized services using technologies such as KVM and VMware on both workstations and servers. Responsibilities include installation, configuration, and support for a variety of non-standard applications including Windchill, Solidworks, license managers, Autocad/Autodesk, Creo, Altium, MATLAB, STK, Thermal Desktop, MagicDraw, LaTeX, Jupyter, GMAT, and GNU compiler toolchains. The Contractor shall ensure compliance with applicable standards such as PIV-M testing configuration requirements across Macintosh and Linux environments.

The Contractor shall deploy, configure, and maintain these tools and services to ensure minimal impact on project and mission requirements. The Contractor shall ensure that configuration management systems and other project-critical systems are protected with redundant backups and that appropriate information assurance and security plans are in place.

The Contractor shall also provide project support to missions through meeting participation and ensure that all code changes are archived in a repository on a government-furnished computer.

4.1.13 Engineering Evaluation Laboratory (EEL)

The Engineering Evaluation Laboratory (EEL) provides engineering test and evaluation capabilities at the prototype, proto-flight, qualification, and certification levels. The EEL has vast testing resources, and whenever those are not sufficient, the staff will typically invent a methodology to provide the required data. The PEMSS contractor staff in the EEL is required to have subject matter expert knowledge and the ability to perform tasks in the areas of structural strength, verification, fatigue testing, monitoring instrumentation, strain gauging, dynamic data acquisition and analysis, modal and spectral analyses for stationary and rotating systems, and loading tests of components and structures. The types of adaptive test engineering employed by the EEL vary from improvising electronic instrumentation, including test analysis and the development of instrumentation controls for experimental investigations using the Government provided testing environment, to manufacturing unique hardware needed to acquire the appropriate data.

The Contractor shall operate and maintain the EEL at NASA ARC, and provide the expertise in the multiple subject areas listed to operate it and meet customer requirements. The Contractor shall plan and perform the following for spaceflight systems and ground-based hardware: 1) perform vibration, thermal vacuum, environmental qualification, structural, impact, and pressure tests, in addition to proof loads and modal testing with resonant frequency analysis; 2) strain gage selection, installation, and data acquisition, reduction, analysis, and reporting; and 3) perform specialty work including installation and testing of all types of engineering measurement sensors, such as accelerometers, pressure transducers, load cells, inclinometers, rate gyros, and temperature and acoustic sensors. The Contractor shall design and fabricate test fixtures and equipment when required to conduct specialized tests.

The Contractor shall also develop and follow stringent verification and validation procedures for aircraft, spaceflight, and critical research facility hardware, and support pre- and post- test reviews as specified in work package requirements.

The Contractor shall keep the EEL clean and free from debris and metal shavings; utilize LabView or comparable system approved by NASA for data acquisition and report generation; calibrate all EEL equipment; complete and follow maintenance plan for all test equipment; and develop and maintain a binder for each piece of test equipment including calibration, maintenance procedures, operating procedures, emergency shutdown procedures, and detailing all known risks when operating the equipment. This information is the property of NASA during the life of the contract and will remain so after the completion of the contract.

4.1.14 Flight Processing Center (FPC)

The Contractor shall provide expertise for flight and ground hardware processes and procedures in assembly, integration & test (AI&T), document control, configuration management, bonded stores, material control, ground handling, shipping and logistics, contamination control and laboratory protocols in support of the FPC. The FPC also includes a 14,000-sq. ft. bonded storage facility for both flight and ground hardware, equipment, and materials. The Contractor shall also provide project assistance with scope of work planning and estimating, Integration & Test (I&T) proposal contributions, and the acquisition of special skills as needed for the FPC.

The contractor shall perform work as specified in work packages to maintain facilities and equipment and provide supplies required to carry out integration and test functions for Center projects. Facilities include an environmentally controlled Class 100K (ISO Class 8) High Bay clean room; two Class 10K (ISO Class 7) clean room facilities used for flight system assembly, integration, test, and handling; prototype-flight fabrication and assembly areas for electronics and mechanical systems; satellite assembly and test areas; science laboratories; test laboratories; bonded storage; a warehouse facility; the MMOC-; project office space; conference rooms; hardware development labs; science laboratory space; and off-line assembly areas. The FPC includes general and specific equipment (GSE) and tools, test equipment, overhead cranes (5.0- and 1.5-ton capacity), and data systems. Supplies include consumables and equipment associated with FPC operations for clean rooms, shipping and receiving, office and administration, assembly and test, and general facilities operations and maintenance.

4.1.15 Metal Fabrication, Machining, and Instrumentation

The Contractor shall provide mechanical and electronic fabrication services and inspection services. Most work will be performed in the shops within the Applied Manufacturing Division (Code RM) at NASA ARC. Some work will be performed at other ARC organizational shops.

The Contractor shall maintain a working knowledge of Workmanship Standards and practices applicable to the work being performed and/or as specified in the assigned work package. Examples of workmanship standards commonly used at ARC are, but not limited to, the ones listed and the end of this paragraph. The Contractor shall also provide certified employees and inspectors per the appropriate standard being used or applied to fabricate, machine, assemble, weld or build end items for ARC. The Contractor shall perform inspections on work products delivered to NASA when instructed to do so by written technical direction to ensure conformance to requirement specifications. Final acceptance inspections for all work fabricated, machined, assembled, welded or built for ARC, shall be performed by NASA ARC SMA Quality Assurance representatives, and/or contractors certified by the SMA Directorate (Code Q), with a delegated authority for final and acceptance inspections. Should there be any questions as to fabrication or inspections requirements, contractor shall abide by statements written in the work packages or task orders and section 2.0 of this document.

As a minimum, these workmanship requirements shall include current revisions of, but not limited to:

Number	Description

NASA APR 8730.3	Ames Electrostatic Discharge (ESD) Control Process
ANSI/ESD S20.20	Protection Of Electrical And Electronic Parts, Assemblies and Equipment
IPC J-STD-001	Requirements for Soldered Electrical and Electronic Assemblies
NASA STD 8739.6	Implementation Requirements for NASA Workmanship Standards
NASA STD 5005C	Standard for the design and fabrication of ground support equipment
NASA STD 5006A	General Welding Requirements for Aerospace Materials
NASA STD 5009	Nondestructive Evaluation requirements for Fracture Critical Metallic Components
NASA STD 8739.3	Soldering of Electrical Connections
NASA STD 8719.9	Lifting Devices and Equipment
NASA STD 8739.4	Crimping, Interconnecting Cables, Harnesses & Wiring
NASA STD 8738.1B	Polymeric Application of Electronic Assemblies

4.1.16 Mechanical Hardware

The Contractor shall provide fabrication services for the manufacturing, modification, repair, and installation of experimental research, prototype, proto- flight, flight, ground, test, critical research facility, and similar hardware.

Expertise is required in conventional and/or Computer Numerical Control (CNC) machining, milling, turning, boring, grinding, broaching, honing, sanding, polishing, bonding, forming, riveting, bending, and welding various materials, such as carbon, stainless, alloy, and structural steels; Monel, Invar, Vascomax, titanium, molybdenum, aluminum, brass, copper, nickel, and bronze; as well as resins, fiberglass, ceramics, plastics, wood, polymers, elastomers, and composite materials. The hardware will be used in such applications as aircraft and spaceflight payloads, small spacecraft, acceleration facilities (centrifuges), arc jets, wind tunnels and test models, man-rated systems, and various astrobiology and nanotechnology projects.

The Contractor shall operate equipment that ranges from hand tools to Computer Numerical Control (CNC) machinery. Welding tasks specified in work packages may require certification to American Welding Society (AWS D1.1) standards.

The contractor shall be required to safely operate machinery, overhead cranes, man-lifts, forklifts, shop lifts and motorized vehicles. Loading and unloading of equipment and materials will require lifting of items weighing up to 50 pounds without mechanical assistance.

The contractor shall follow all safety rules and regulations as they pertain to each of the fabrication and machining facilities as each have unique hazards. Safety training is required, including, but not limited to, crane operator and signal person, forklift, confined space, man lift/aerial lift, respirator, and hazardous waste operations, as well as enrollment into the hearing conservation program.

When certifications and licenses are required to perform work, contractor staff shall be trained to meet the requirements specified by OSHA, State, and Federal regulations for certification or license to perform the duties required by their job function. In some cases NASA requires specialized safety training and certifications in addition to the regulatory requirements, which is defined in the "Ames Health and Safety Manual" APR 8715.1 https://cdms.nasa.gov/assets/docs/centers/ARC/Dirs/APR/APR8715.1.html. The Contractor shall ensure that employees maintain all of their certifications and licenses, as specified in each work package, to perform these duties.

The contractor shall follow all rules and regulations pertaining to use of Personal Protective Equipment (PPE). If required, PPE shall be worn and maintained in accordance with Occupational Safety and Health Administration (OSHA), NASA and ARC requirements. PPE to be used shall be provided by the contractor and include, but not be limited to, safety glasses, steel toe boots, hearing protection, hard hats, welding helmet, gloves and overalls.

4.1.17 Electronics

The Contractor shall provide fabrication services for the manufacturing, modification, repair, and installation of experimental research, prototype, proto- flight, flight, ground, test, and similar electronics. Tasks will include printed circuit board (PCB) layout fabrication, assembly, test, and repair; chassis fabrication and wiring, and cable harness fabrication; troubleshooting with and without schematics and modifying existing designs to meet new requirements. The decision to make or buy (outsource) these services will be at the discretion of the Contractor. However, the Contractor shall provide the most advantageous cost and schedule benefit to the Government. The Contractor shall meet NASA's requirements for workmanship and electrostatic discharge control as specified in the engineering design documentation or work package/task order requirements.

4.1.18 Inspection Services

The Contractor shall provide inspection services on work products for experimental research, prototype, proto-flight, flight, ground, test, research facility, electronics fabrication, and similar hardware to ensure conformance to requirements specifications. Certification to the American Society for Quality (ASQ) standards for the mechanical inspector may be required. Certification to NASA or industry standards for electronics inspector may be required.

Certification requirements will be stated in the work package or task order.

4.1.19 Production Planning and Scheduling

The Contractor shall provide production planning services to include estimating and scheduling in support of Code RM's planning function. The Contractor shall provide detailed estimates which include as a minimum material quotes, labor estimates, and identification of special processes. The work requires knowledge of manufacturing processes, machining, fabrication, welding and bonding. The Contractor shall maintain and develop weekly production schedules for deliverables and in-house production

processes.

The Contractor shall provide services to plan, prepare, issue and maintain production control schedules which will be used for internal and external reporting. Production control schedules shall incorporate “man loading” schedules and resource loading to ensure project and production schedules are maintained.

The Contractor shall also be responsible for generating materials requirements documents based off requirements documents, statements of work, and drawings or blueprints. The work requires a general understanding of materials and material nomenclature, including types of metals as well as some non- metallic materials.

The Contractor shall be responsible for job package creation as well as production travelers. This requires a basic understanding of production and manufacturing processes in conjunction with basic knowledge of inspection/quality requirements, plating and coatings specifications, materials, and mechanical assemblies. The Contractor shall work directly with other production planners as well as craftspeople on the production floor to gather information daily pertaining to work status and production progress.

The Contractor shall support the development of detailed production and fabrication estimates for the government to use in evaluating quotes; therefore, the Contractor shall provide estimates which include cost and schedule details. Estimating will require generating request for vendor pricing using electronic spreadsheets, emails, phone calls and solicitations to vendors. The Contractor shall assign employees who possess strong oral and writing skills to articulate requirements and request quotations which will be used in the estimating process.

The Contractor shall monitor production progress and be able to gather pertinent data which will be entered into a production control database. These duties will also include tracking its employee hours and budgets to ensure estimates and actual costs are monitored and reported to ARC for internal NASA tracking and customer reporting. The contractor shall monitor its employees’ timecards and hours logged to ensure accuracy of reports and data are maintained.

The contractor shall also be responsible for material control, will-calls and bonded storage of hardware and procurements in support of assigned work. Material control consists of receiving materials from incoming shipments and identifying material, labeling and filing and archiving of paperwork. Incoming shipments of material will require a cursory inspection of materials and paperwork to ensure the product meets the desired specifications. Will-calls will require the contractor to deliver hardware, material and parts to various vendors for secondary processes such as grinding, plating and inspection. The Contractor shall provide staff to support this effort that are able to lift heavy items up to 50 pounds and secure them for transport using government supplied vehicles. The Contractor shall track hardware and parts while they are being processed at outside vendors. This consists of producing shippers, signing process sheets as well as dropping off and picking up parts from outside vendors. The Contractor shall ensure that materials are appropriately controlled using a bonded storage facility. The Contractor shall be responsible for checking hardware and material in and out as it arrives and leaves the premises.

The Contractor shall plan and schedule meetings with onsite customers to disseminate

production status, including cost and schedule updates. Meeting intervals will be based on project needs and will include both contractor and civil servant staff. Reports and meeting minutes may be required, and the Contractor shall generate and disseminate to groups or individuals via email for documentation and record keeping.

The Contractor shall assist authorized civil servant bank card users with resolving monthly billing by data gathering of procurements and purchase orders related to contract tasks. This process requires the contractor to have a general understanding of finance, billing and reconciliation.

The Contractor shall be responsible for following shop safety practices and participating in safety inspections by OSHA, NASA and ARC internal Safety and Mission Assurance (Code Q) personnel. Contractor personnel shall attend safety training classes on site as well as off-site classes and certifications. The Contractor shall adhere to all shop safety regulations as detailed in APR 8715.1.

The Contractor shall follow all hazardous waste disposal processes and procedures. This includes training of personnel to handle and record waste generated as well as request for disposal and pick up if hazardous waste generated on site. The Contractor shall conduct chemical inventories, create chemical usage reports, request approvals for procuring of new chemicals and monitoring inventories of waste generation and disposal. The contractor shall also participate in hazardous waste and air quality audits which will include providing necessary paperwork, permits, records and process documentation.

4.1.20 Space Shop

Under government supervision, the Contractor shall operate and staff the Space Shop which consists of state-of-the-art digitally automated manufacturing equipment such as 3D printers, Laser cutters, CNC routers, woodworking equipment, and additive manufacturing equipment.

The contractor shall manage Space Shop operations which include the following: understand and operate all equipment, maintain a clean safe working environment for users, train new users (typically less than once a week) to safely operate and effectively use the shop equipment, maintain and update training materials, perform monthly safety walkthroughs and inspections, assist with safety audits, dispose of hazardous materials, maintain necessary supplies and tools, monitor sign-up sheet and automated sign-in kiosks, coordinate required contractor staffing, and monitor operations.

4.2 Engineering Support

4.2.1 Systems Engineering

The Contractor shall provide Systems Engineering support in accordance with NPR 7123.1 unless otherwise specified in work package or task order requirements. Systems engineering includes support for requirements definition, tracking, verification and validation of requirements, developing product and work breakdown structures, developing schedules, identifying and developing interface control documents, managing

the technical effort, analyzing and managing risks, conducting design trade studies including recommendations for alternative concepts and approaches when necessary, creating test plans, test procedures and test reports, overseeing tests, performing life cycle cost analysis, and managing all technical documentation. Some tasks will require familiarity with various commonly used systems engineering tools such as Confluence, Jira, Windchill, and Cradle, and methods such as full system analysis and optimization, parametric and hierarchical analysis, process analysis, life cycle cost analysis, risk analysis, decision support analysis techniques and functional and data modeling.

The Contractor shall apply systems engineering to traditional hardware and software development projects and to conceptual technology development projects where no hardware or software is developed. The contractor shall perform trade studies, simulation, risk analysis and other conceptual work as required.

4.2.2 Design and Development

The Contractor shall design and develop and/or implement systems that will be used in spaceflight flight systems such as spacecraft, hardware and payloads, including hardware and payloads for the International Space Station (ISS); aircraft; robotics; ground support hardware; facility support hardware; wind tunnels; information systems; centrifuges; and other research and development facilities. Design efforts may vary in scope. The work will encompass development of new systems or modifications to existing facilities and/or equipment, oversight of fabrication, construction, and installation. As authorized in the work package, the contractor may use Commercial-Off-the-Shelf (COTS) hardware or systems in the implementation of project requirements, rather than in-house design/development, to provide the best value to meet the Government's project requirements. The work will involve multiple engineering disciplines as detailed in the sections below. Typical system operating environments include biological, commercial, airborne, ground support, and spaceflight (from Low Earth Orbit (LEO) to Deep Space).

4.2.3 Mechanical

The Contractor shall perform the work by providing expertise in all areas of mechanical engineering, including machine design, structural design and analysis, thermal design and analysis, and fluid mechanics. Applications will include spacecraft and aircraft systems design, ground-based experimental facilities (such as arc jets; wind tunnels; flight simulators and acceleration facilities or centrifuges); life science experiment hardware and space-flight payloads (such as plant growth, animal habitat, and cell culture systems); space flight; small satellite systems; airborne and ground- based instruments; robotics; wind tunnel models; and aircraft modifications.

Additional information and requirements related to these disciplines and applications are provided below.

4.2.3.1 System Design

The Contractor shall perform the work by providing expertise in all areas of system design. The expertise will require knowledge of mechanics, kinematics, materials selection, joint design, drive systems (mechanical and electrical), heat transfer, fluid mechanics, thermodynamics, and fabrication techniques. The contractor shall produce or modify mechanical drawings that meet NASA and ARC engineering and fabrication standards, including use of the Government-provided Pro- Engineer/Creo tools for modeling and drafting. Tasks may include the design and engineering of spacecraft mechanisms, instruments, spaceflight payloads, prototypes and models, test beds, unique research facilities' systems (including building structures, piping, and specialized research and development (R&D) facility systems (e.g., arc jets, wind tunnels, centrifuges, and simulators)), and aircraft modifications.

4.2.3.2 Structural Design and Analysis

The Contractor shall perform the work by providing expertise in all areas of structural design and analysis. The contractor shall perform Finite Element Modeling and Analysis using Government-provided tools or applications such as MSC/PATRAN, Mechanica, Creo Simulate, MSC/NASTRAN, and ASME B31 code design using CEASAR II Pipe Stress Analysis, in addition to the application of experimental methods and closed-form solutions. The assigned tasks may include the design of structures with determination of applied loads, stress analysis of structures with factors of safety on failure modes, deflection analysis, materials selection, and analysis of joints (e.g., welded, bolted, riveted, and bonded). The work also includes composites engineering design and analysis that requires knowledge of composites construction, composite bonding and assembly, and tool construction or utilization. Analysis should account for all forms of structural loading, including gravitational, inertial, vibration, fluid, aerodynamic, and thermally induced forces.

4.3 Science Support

The Contractor shall provide comprehensive technical, operational, and analytical support to execute complex scientific research, mission planning, and technology development initiatives. This encompasses the full lifecycle of scientific operations, spanning biosciences research, exploration science, facility safety, and the programmatic integration of research portfolios.

4.3.1 Scientific Research and Laboratory Operations

4.3.1.1 Applied Science & Investigations: Provide direct scientific research and technical support for complex science activities, including laboratory investigations, field experiments, and flight investigations/experiments.

4.3.1.2 Biosciences & Veterinary Operations: Manage and operate comprehensive biological and laboratory animal care programs. Provide specialized veterinary science, animal husbandry, and research support ensuring strict compliance

with federal and institutional regulatory frameworks (e.g., Animal Welfare Act, PHS guidelines, and IACUC standards).

4.3.1.3 Biospecimen & Scientific Asset Management: Provide technical planning, risk assessment, and execution oversight for biological specimen sharing programs. Formulate complex dissection protocols, conduct rigorous tissue quality verifications, perform data analysis, and manage the technical distribution of biological samples to research archives and Principal Investigators.

4.3.1.4 Mission Science Integration: Lead Payload Developers and Principal Investigators through rigorous scientific and technical review gates. Define technical requirements, operational plans, and success criteria, while actively assessing technical status, mitigating risks, and managing schedule progress for flight and ground-based scientific grants.

4.3.2 Laboratory Safety and Controlled Space Compliance

4.3.2.1 Laboratory & Clean Room Safety Programs: Implement and manage rigorous safety, health, and contamination-control programs for complex research laboratories and clean room spaces. This includes technical oversight of industrial hygiene, radiation safety, specialized air quality standards, and biological hazard protocols (e.g., Biosafety Level 2 and Risk Group 2 compliance).

4.3.2.2 Scientific Workspace Compliance & Hazard Management: Oversee technical safety compliance within specialized research spaces. This encompasses routine laboratory inspections, clean room certification tracking, hazardous material handling and waste procedures, and technical oversight for the safe relocation, modification, or decommissioning of scientific laboratories and specialized workspaces.

5.0 Phase-In / Phase-out

5.1 Phase-in

The contractor shall adhere to the Phase-in Plan submitted and approved as part of the contract award. The plan will cover the 60-day phase-in period. The intent of the plan is to minimize changeover difficulties and maximize continuity of services to NASA. The phase-in process shall not adversely impact the work being done by the outgoing contractor. It shall be conducted in a manner consistent with safe operations requirements. The incoming contractor is responsible for providing a qualified contractor staff by the end of the phase-in period at which time it will assume full responsibility for the performance of requirements which Technical Direction has been given.

5.2 Phase-out

The Contractor shall provide a Phase-Out Plan for the complete and orderly transfer of

duties and records to the incoming Contractor. Any and all standard operating procedures and documentation developed during this contract that is needed to successfully operate systems, perform job functions, and complete task in progress on the contract need to be provided. The Plan shall address issues pertinent to the continuation of safe operations for all areas of responsibility under the contract. The draft Phase-Out Plan is required 120 days before the end of the contract's period of performance. Government will provide comments within 10 calendar days; final report is due to Government 5 days after receipt of comments for final approval. All standard operating procedures and documentation developed during this contract that is needed to successfully operate systems, perform job functions, and complete task in progress on the contract need to be provided as part of the phase out plan.

6.0 ACRONYMS

AI&T	Assembly, Integration, and Test
AO	Announcement of Opportunity
AMS	Ames Management System
ADCS	Attitude Determination and Control Systems
APD	Ames Policy Directives (APD)
APMS	Ames Power Monitoring System
APR	Ames Procedural Requirements
ARC	Ames Research Center
ASIST	Advanced Spacecraft Integration and System Test
ASQ	American Society for Quality
AWS	American Welding Society
CAD	Computer Aid Design
CCB	Change Control Board
CDRL	Contract Deliverable Requirements List
CFD	Computational fluid dynamics
CNC	Computer Numerical Control
CO	Contracting Officer
COR	Contracting Officer's Representative
C&DH	Command and Data Handling
COTS	Commercial-Off-the-Shelf
eCC	electronic Country Clearance
EE	Electrical Engineer
EEL	Engineering Evaluation Laboratory
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
FISMA	Federal Information Security Management Act
FMCS	Facility Management Control System
FPC	Flight Processing Center
G&A	General and Administrative
GFE	Government Furnished Equipment
GN&C	Guidance Navigation and Control
IDIQ	Indefinite Delivery/ Indefinite Quantity
ISS	International Space Station
IT	Information Technology
ITOS	Integrated Test and Operations Systems

JO#	Job Order Number
LASP	Laboratory for Atmospheric and Space Physics
LEO	Low Earth Orbit
MDC	Mission Design Center
ME	Mechanical Engineer
M&S	Material and subcontract
MS	Microsoft
MMOC	Multi-Mission Operations Center
NASA	National Aeronautics and Space Administration
OSHA	Occupational Safety and Health Administration NPD
	NASA Policy Directive
NPR	NASA Procedural Requirements
NRP	NASA Research Park
OASIS	Observation and Analysis of Smectic Islands in Space
ODC	Other Direct Cost
PCB	Printed Circuit Board
PEMSS	Project Engineering, Manufacturing, and
Science Services	
PI	Principal Investigator
PPE	Personal Protective Equipment
ROM	Rough Order of Magnitude
R&D	Research and Development
RPM	Revolutions per Minute
SME	Subject Matter Expert
SMA	Safety & Mission Assurance
SOW	Statement of Work
SSP	System Security Plan
TD	Technical Direction also synonymous with Work Package(s) WP(s)
TPOC	Technical Point of Contact
TPS	Thermal Protection Systems
WP(s)	Work Package(s) also synonymous with Technical Direction (TD)

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7.0 APPENDICES

7.1 Standards and Codes

The nature of the research work at ARC dictates that we comply with many different current standards and codes. Those that are applicable will be called out on the task order or work package. Typical standards and codes that may be imposed on the Contractor are listed below.

1. ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code
2. ASA (Acoustical Society of America) Codes as sponsored by the ASME
3. Department of Transportation regulations
4. NEC (National Electric Code)
5. Military Specifications and Standards
6. ASTM (American Society of Testing and Materials) Standards
7. NASA and Ames Research Center Standards and Procedures.
8. Mechanical and Structural Design Manual for the Systems Engineering Division, Ames Research Center.
9. ANSI (American National Standards Institute) Standards
10. IEEE (Institute of Electrical and Electronic Engineers) Standards.
11. AWS (American Welding Standards)
12. EDC (Engineering Documentation Center) Document Standards
13. NHB 1700.1 (V1-B), NASA Safety Policy and Requirements Document
14. Ames Environmental Handbook (APG 8800.3)

7.2 Potential Contract Documentation Requirements/Deliverables

7.2.1 For Contract Management

For the Contract Management requirements, the Contractor shall deliver all contract deliverables, reports, and plans identified and described in Section J(a), Attachment 3, "Contract Data Requirements List" (CDRL).

7.2.2 For Technical Requirements

The contractor shall perform the technical functions to produce the deliverables as specified in the work package TD issued under task orders under IDIQ CLINs. Deliverable may include:

<u>Reports/Plans</u>

- Engineering Documentation, including but not limited to:
    - Design and Development of Systems and Processes

- Design and engineering drawings and as-built documentation and modifications
- Computer Aided Design/Computer Aided Engineering (CAD/CAE) files
- Requirements Documents
- Finite Element Models (FEM)
- Mathematical models and associated data sets
- Results of Analysis and Studies, including methodology, ground rules and assumptions
- Status Reports
- Hardware Development Reports including fabrication procedures
- Test Plans, Procedures, Calibration, Set-up and Characterization
- Test/Analysis Correlations
- Comparison of Test Results to Analysis
- System, architecture, and mission concepts and plans
- Methodologies and Tool Development
- Assessments
- Problem/Failure/Action
- Technical Problem formulation
- Trend Analysis
- Summaries and Action Items from technical meetings and reviews
- Lessons Learned Documentation
- Configuration and Data Management Plans
- Laboratory Maintenance Logs
- Technical activity logs such as grid generation and simulation
- Project/Work Plans
- Risk Management Plan
- Schedule and Budget Reports
- Integrated Master Schedules

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- Schedule Master Plans
- WBS dictionary and hierarchical graphs
- Facility work plan describing lab processes and hardware/software utilization
- Verification & Validation Plans
- Implementation Plans
- Fracture Control Plans
- Configuration & Data Management Plans
- Configuration Item List
- Interface Control Documents
- User guides and manuals
- Presentations and briefings
- Graphic reports, Network Diagrams, Gantt Charts, Resource Histograms
- Edited documents such as reports, plans, handbooks and presentations

- Technical reports, technical memorandums, conference papers, presentations, "white papers", and journal articles

- Engineering drawings and specifications

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