

ATTACHMENT A

SYSTEMS ENGINEERING ADVANCED SERVICES (SEAS)

STATEMENT OF WORK (SOW)

RFP NNG15499015R

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INTRODUCTION

The National Aeronautics and Space Administration (NASA) were established to plan, direct, and conduct aeronautical and space activities for peaceful purposes for the benefit of all mankind. The operational aspects of NASA's work are divided among field installations around the country and involve research and development activities under the responsibility of four technical program offices at NASA Headquarters.

The Goddard Space Flight Center (GSFC) has primary locations in Greenbelt, Maryland and Wallops Island, Virginia. The GSFC is chartered to expand the knowledge of the earth and its environment, the solar system, and the universe through observations from space. To this end, the GSFC's primary emphasis is in scientific investigation, in the development and operation of space systems, and in the advancement of essential technologies. In accomplishing this responsibility, the GSFC has undertaken a broad program of scientific research, both theoretical and experimental, in the study of space phenomena and earth sciences. The program ranges from basic research to flight experiment development and from mission operations to data analysis.

Within the GSFC, the Applied Engineering Technology Directorate (AETD) plans, organizes, and conducts a broad range of technical research and development activities in support of science applications. The AETD is responsible for providing engineering expertise and support in the formulation, design, development, fabrication, integration, test, verification, and operation of components, subsystems, systems, science instruments, and complete spacecraft for multiple projects. The specific components, subsystems, systems, and science instruments are ultimately integrated into the spacecraft to form a science observatory. It is these observatories that are launched to fulfill the mission of the GSFC. The AETD comprises five engineering divisions: the Mechanical Systems Division (MSD), the Software Engineering Division (SED), the Instrument Systems and Technology Division (ISTD), the Electrical Engineering Division (EED), and the Mission Engineering and Systems Analysis Division (MESAD).

To fulfill these responsibilities and ultimately achieve their missions, the AETD must acquire a wide range of engineering services in support of its divisions to implement the GSFC mission.

SCOPE OF WORK

The contractor shall, pursuant to Task Orders issued by the Contracting Officer, provide Mission and Instrument Systems Engineering (M&ISE) services to the Mission Engineering & Systems Analysis Division (MESAD) and related Applied Engineering and Technology Directorate (AETD) organizations, for the formulation and implementation of, flight and ground systems, and development and validation of new technologies.

The contractor shall, pursuant to Task Orders issued by the Contracting Officer, provide M&ISE services in all aspects of mission and instrument formulation and implementation for systems, science instruments, observatories, launch, ground system, spacecraft, and suborbital craft (e.g., aircraft, sounding rockets, unmanned aerial vehicles (UAVs), balloons), including

services for the following: free-flying spacecraft, suborbital craft payloads, and Space Station payloads.

The contractor shall, pursuant to Task Orders issued by the Contracting Officer, provide on/off-site M&ISE services. These services shall include the personnel, facilities, and materials (unless otherwise provided by the Government) to accomplish the tasks.

I. GENERAL RESPONSIBILITIES

The contractor shall provide the establishment of a management organization for the management of personnel, timely and effective implementation of Task Orders, control and monitoring of contract and subcontract performance, management of scheduled deliveries, and timely and effective reporting to the Government.

The contractor shall provide to the government efficient methods for cost management and task order progress and status, throughout all phases of work called out in this statement of work.

The Contractor shall be responsible for ensuring that all contractor and subcontractor personnel engaged in performance of this Statement of Work have appropriate qualifications, knowledge, and certification to perform work in accordance with the Task Orders.

Function 3 of the SEAS Statement of Work, "RESEARCH AND TECHNOLOGY SERVICES", directs systems engineering analysis and test activities to be conducted which may necessitate short term and limited application of hardware and hardware development on the SEAS contract.

Electronic and Information Technology (EIT) Section 508 Compliance

In order to comply with the Section 508 Electronic and Information Technology Accessibility Standards, the contractor shall perform all work required under this contract in compliance with the following technical standards delineated in Code of Federal Regulations (CFR) Title 36:

- 1194.21 Software Applications and Operating Systems
- 1194.22 Web-based Intranet and Internet Information and Applications

II. PERFORMANCE MEASUREMENT

Performance-based statements of work/specifications will be used for establishing contract requirements. Therefore, each Task Order issued by the Contracting Officer will include, as a minimum, the following:

1. Statement of Work, including the requirements to be met, the standard(s) of performance/quality of work, and required deliverables (or other output)

2. Performance Specification (if applicable)
3. Applicable Documents (if required)
4. Period of Performance
5. Surveillance Plan

The Contractor shall be required to adhere to the performance measurements detailed in each Task Order.

III. TASK ORDERS

The contractor shall, pursuant to Task Orders issued by the Contracting Officer, provide M&ISE services required in one or more of the areas described in the scope of work. M&ISE services within the scope of this Statement of Work and specified in Task Orders shall include the services delineated in the following sections.

FUNCTION 1 – FORMULATION PHASE SERVICES

The Contractor shall provide primarily Mission and Instrument Systems Engineering (M&ISE) services, with discipline engineering support services as required, for formulation phase development, that integrates the aspects of flight systems, ground systems, instrument systems, and launch systems.

The Contractor shall provide Mission and Instrument Systems Engineering (M&ISE) support for project development, documentation, reporting progress, and conformance to appropriate practices and specifications, as called out in the applicable documents and specifications section of this statement of work.

A. General Study Services

The Contractor shall provide general study services for the formulation of systems, and identification of scientific objectives, mission requirements and technical concepts.

Contractor study products provided shall include:

- a. Tracks and oversees production of pre-formulation and formulation phase study inputs for spacecraft, suborbital craft, and instruments.
- b. Develop mission needs (mission objectives, measurement concept, and instrument concept) and mission design (mission requirements, instrument requirements, architectural design, and operations concept).
- c. Develop preliminary, relative cost and schedule estimates based on design alternatives, and identify and assess high-risk elements in designs.
- d. Document the history of design, qualification, flight experience, and modifications where existing components or subsystems are to be utilized.
- e. Identify interface requirements for pre-launch, launch, on-orbit servicing, or retrieval of flight hardware.
- f. Define interface engineering and management requirements.
- g. Prepare mission systems and operations documentation.
- h. Prepare requirements and specification packages that conform to applicable standards defined within Task Order statement of work.
- i. Identify interfaces and prepare interface control documents.
- j. Provide technical inputs for problem-solving and/or design inputs in selected spacecraft, instruments, suborbital craft, ground system, and data disciplines.
- k. Analyze various reports (i.e., progress reports) delivered by the GSFC mission contractor(s) and provide recommendations to the project.
- l. Provide liaison and coordination services for project activities.
- m. Provide M&ISE services that include performance of preliminary system design (leading to a Preliminary Design Review) of the instrument/spacecraft/platform/launch system.

The contractor shall provide personnel with security clearances for tasks ranging from Secret to Top Secret and Sensitive Compartmental Information (SCI).

The contractor shall comply with applicable NASA, DoD, National Industrial Security Program Operating Manual (NISPOM) and Director of Central Intelligence Directives (DCIDs) security regulations.

B. Candidate Study Services

The Contractor shall provide candidate study services for the conceptual design and development of systems, and identification of scientific objectives, mission requirements and technical concepts.

Contractor study products provided shall include:

- a. Strategic technology planning
- b. Integration of joint missions, partnerships, and other collaborative efforts
- c. Research/science/technology/cost trade studies
- d. Candidate operations concepts
- e. Candidate system architectures
- f. Cost, schedule, and risk estimates
- g. Research and technology unique to system development
- h. Customer development support and outreach

The Contractor shall document all results in a candidate study report.

C. Preliminary Analysis Study Services

The Contractor shall provide preliminary analysis study services focusing on analyzing mission requirements and establishing mission architectures in order to demonstrate that a credible, feasible design(s) exist(s).

The Contractor shall provide top-level requirements and evaluation criteria, identify alternative operations/logistics concepts, and identify project constraints and system boundaries.

Contractor study products provided shall include:

- a. Preliminary system design of a feasible, but not necessarily optimum configuration.
- b. Assessment of technical risks, including identification of technical problems and

the criticality of their solution to follow-on efforts; identification of those problems currently being addressed, and a judgment of effort and time likely to be necessary to find a practical solution.

- c. Identification of all recommended systems characteristics, including launch and control capability, tracking and data acquisition, facility considerations, and institutional base activities.
- d. Implementation plans, which include the identification of all major systems and subsystems
- e. Preparation of the system design that forms the basis for implementing system development (hardware or software).
- f. Provide alternative design concepts including feasibility and risk studies, cost and schedule estimates, and advanced technology requirements.
- g. Prepare for and support the appropriate Phase A project and technical reviews and prepare Phase A project documentation as appropriate (see the NASA Systems Engineering Handbook, SP-6105, December 2007).

The Contractor shall document all results in a Preliminary Analysis Study Report.

D. System Definition Study Services

The Contractor shall provide system definition and preliminary design study services to establish (and evolve) the project baseline(s).

Contractor study products provided shall include:

- a. Defining system requirements, system budgets (e.g., mass, power, memory), error budgets, system/subsystem requirements, software requirements, ground support equipment requirements, and integration and test requirements.
- b. Identifying all recommended system characteristics; defining the subsystem components and assemblies; identifying the required complement of flight and ground support equipment; specifying internal and external interfaces; and verifying that the recommended design approach's critical subsystems and components are within the state-of-the-art.
- c. Providing a formal flow down of project-level performance requirements to a complete set of system and subsystem design specifications for both flight and ground elements. Phase B baseline information shall be developed including system requirements and verification requirements matrices; system architecture and work breakdown structures; operations concepts; "design-to" specifications at all levels; and project plans including schedule, resources, and acquisition strategies.
- d. Performing risk assessments of all critical elements, describing the risks and control methods. The knowledge and use of Probability Risk Assessment (PRA), Failure Modes and Effects Analysis (FMEA) and Fault Tree Analysis (FTA) is required.

- e. Preparing the system design that shall form the basis for implementing/developing the system (hardware or software); defining the tasks and sequence of tasks that shall be performed to provide orderly technical development, design, review, interface, test, and integration of the system; and providing the required plans (modeling, analysis, and simulation; configuration; logistics; information; software; verification; integration and test, etc.) for the effort.
- f. Describing and documenting integrated mission architecture.
- g. Preparing for and supporting the appropriate Phase B project and technical reviews and preparing Phase B project documentation as appropriate (see the NASA Systems Engineering Handbook, SP-6105, December 2007).

The Contractor shall document all results in a System Definition Study Report.

FUNCTION 2 – IMPLEMENTATION PHASE SERVICES

The Contractor shall provide Mission and Instrument Systems Engineering (M&ISE) services, for implementation phase development that integrates the aspects of flight systems, ground systems, instrument systems, and launch systems.

The Contractor shall provide Mission and Instrument Systems Engineering (M&ISE) support for project development, documentation, reporting progress, and conformance to appropriate practices and specifications, as called out in the applicable documents and specifications section of this statement of work.

The Contractor shall provide services for implementation phase tasks that include:

A. Operations Concept Development & Support:

- a. Developing the operations concept.
- b. Preparing/reviewing operations concepts in regards to the intended functionality and interfaces among the flight subsystems and the ground.
- c. Generating Operations Concept Documents (ConOps).
- d. Participating in user interface meetings and joint integrated mission simulation training aimed at developing viable user operations.
- e. Supporting satellite operations.
- f. Analyzing flight anomalies and recommending implementing appropriate actions.
- g. Working with principal investigator and science working group in planning operations.
- h. Supporting “lessons learned” presentations.
- i. Preparing plans for and supporting mission disposal operations.

B. Architecture & Design Development:

- a. Defining systems, system architectures, and conducting trade-off studies/design studies for spacecraft, suborbital craft, instruments, space segments and ground segments.
- b. Reviewing system development and system test activities.
- c. Generating and maintaining and/or reviewing system block diagrams.
- d. Characterization of the technology readiness levels for all candidate technologies.

C. Requirements Analysis, Identification and Management:

- a. Generating and managing and reviewing requirements.
- b. Conducting requirements traceability.
- c. Documenting specified and lower-level derived requirements to demonstrate that performance requirements are met.

- d. Reviewing/performing independent design and development requirements analyses, and submitting comments and recommendations.
- e. Reviewing technical specifications, and submitting comments and recommendations.
- f. Reviewing contamination control requirements.
- g. Reviewing operating plans and procedures for cryogenics, fuels, and other hazardous materials.

D. Validation and Verification:

- a. Generating and/or reviewing Verification Plans
- b. Performing design, drawing, and specification reviews
- c. Providing comments and/or recommendations to ensure:
 - i. Designs meet specification and interface requirements.
 - ii. Appropriate parts standards are compatible with specified mission requirements and risk levels.
 - iii. Detailed specifications are compatible with mission requirements, including margin and error budgets.
 - iv. Proper consideration is given to cost, reliability, safety, non-flight fabrication requirements, contamination control, magnetic materials/interference, launch requirements, and space environmental requirements.
- d. Documenting and/or reviewing system qualification requirements.
- e. Preparing and/or reviewing hardware and software integration plans and procedures.
- f. Preparing and/or reviewing detailed functional, comprehensive, and environmental test plans and procedures.
- g. Ensuring execution of integration and test plans.
- h. Ensuring that the technical aspects of shipping requirements and equipment are met.
- i. Preparing and/or reviewing plans for launch site checkout, integration and testing of flight systems, including adequacy of the launch site facility.
- j. Analyzing data from spacecraft telemetry data sources to ensure complete system compatibility.
- k. Analyzing performance using spacecraft and instrument telemetry.

E. Interfaces and Interface Control Documents (ICDs):

- a. Reviewing and analyzing design interfaces
- b. Identifying interface control requirements for engineering and design of components for launch, on orbit servicing, or retrieval of flight hardware
- c. Preparing, reviewing, and analyzing interface documentation for mission systems
- d. Preparing interface control documents and verifying proper implementation for flight and ground systems and subsystems
- e. Controlling external interface documentation and requirements

F. Environment Requirements:

Defining, reviewing and analyzing system specifications to ensure that they meet the specified environments including Mechanical systems, Electrical systems, EMI/EMC, Grounding, Thermal, Radiation, Parts engineering, Contamination, Reliability, Charging, Timing and time distribution, Data rates, Safety, and Orbital debris.

G. Technical Resource Budget Tracking:

Documenting, controlling and/or reviewing budget plans, including power, thermal, data storage, computer processing and communication through-put, attitude control, timing, mass properties, command and telemetry signal margin and bit error rates etc., both at the flight system level and allocated to lower levels of assembly. This shall include error margins, where applicable.

H. Risk Analysis, Reduction, and Management:

- a. Identifying high risk elements and developing/executing contingency plans for controlling the high risk elements
- b. Reviewing contractor risk management plans and commenting on alternate approaches

I. System Milestone Reviews:

- a. Conducting and documenting internal design reviews
- b. Supporting standards definition and review
- c. Attending and conducting technical meetings/design reviews, and submitting comments and recommendations
- d. Preparing and presenting of technical information for technical conferences/reviews/briefings

J. Configuration Management and Documentation:

Analyzing configuration, design, anomaly resolutions, and procedural changes submitted to change control boards.

K. Systems Engineering Management Plan:

- a. Generating System Engineering Management Plans (SEMP).
- b. Documenting/reviewing system, subsystem and organizational processes in terms of ISO compliance, NASA Standards as well as GSFC GOLD Rules.
- c. Developing or reviewing existing systems engineering tools for applicability as required.

L. Integration, Test, and Verification Services:

- a. Integrating and verifying the flight, ground systems, and science data system

- b. Preparing and executing test plans
- c. Documenting all non-conformances and dispositions
- d. Providing operating manuals, reference documents, training, and launch site support.

M. Launch Site Preparation and Post-Launch support:

- a. Support to flight and ground systems and its support equipment
- b. Interfaces to the mission operations control centers
- c. Technical services to facilitate interfacing with the launch site organization
- d. Development of launch site support requirements
- e. Development of launch site plans and procedures
- f. Support for shipment of the flight hardware and associated support equipment to and from the launch site.
- g. Post-flight summary reports, analyzing the performance of the system during flight.

FUNCTION 3 – RESEARCH AND TECHNOLOGY SERVICES

The contractor shall provide advanced Mission and Instrument Systems Engineering (M&ISE) support for research and technology support to MESAD and related AETD organizations. These services include development, test and analysis work in support of the Research and Technology activities.

The Contractor shall provide Mission and Instrument Systems Engineering (M&ISE) support for project development, documentation, reporting progress, and conformance to appropriate practices and specifications, as called out in the applicable documents and specifications section of this statement of work.

A. Instrument Systems Technology Services

The Contractor shall provide systems engineering services for research, design, development, and testing, and analysis for instrument systems, including:

1. **Instrument Systems Specific Task Orders**– The Contractor shall provide system engineering services for the research and development of advanced analytical, engineering, integration, testing, and software engineering techniques including:
 - a. Instrument Systems Performance modeling
 - b. X-Ray, Ultraviolet, Optical, and Infrared Instrument systems performance testing and analysis
 - c. Particle and field Instrument design development and analysis
 - d. Instrument Systems signal to noise analysis
 - e. Advanced hyperspectral imaging concepts
 - f. Microwave and sub-millimeter wave radiometer advanced concepts and performance modeling
 - g. Lossless and lossy compression algorithms
 - h. Science data archival formats and data distribution methods
 - i. Instrument applications of computational optics
 - j. Synthetic Aperture Radar advanced concepts
 - k. Computational Image enhancement
 - l. Autonomous Instrument systems

B. Instrument Electronics Systems Technology Services

The Contractor shall provide systems engineering services for research, development, test, and analysis of advanced signal processing electronics for space flight systems, including support for language-based microelectronics development.

The Contractor shall provide system engineering services for sensor signal processing technology Task Orders, digital signal processing technology Task Orders, and advanced applications technology Task Orders.

C. Software Systems Technology Services

The Contractor shall provide systems engineering services for the research and development of advanced software topics, including:

1. Automation and artificial intelligence applications
2. Software engineering
3. Distributed processing
4. Internet applications
5. Embedded software systems
6. Scientific data analysis
7. Visualization and virtual environments
8. Data processing, archival and distribution
9. Simulation and modeling
10. Middleware

D. Systems Technology Services

The Contractor shall provide systems engineering services for the research and development of advanced technologies for end-to-end mission architectures, systems, for spacecraft, balloons, UAV's, sounding rockets, instruments, and other platforms, including:

1. Technology validation
2. Technology infusion
3. Technology state-of-the-art and gap analyses
4. Strategic technology planning and road mapping
5. Technology study/proposal support
6. Technology infrastructure/facility requirements planning
7. Technology special studies, including the development and refinement of technology enabled missions
8. Technology tracking, documentation and reporting
9. Technology prototyping

FUNCTION 4 – SUPPORT SERVICES

A. Document Services

The Contractor shall provide documentation services within the scope of this Statement of Work, as specified in Task Orders. Documents shall conform to applicable documents and specifications. These shall include pertinent performance assurance guidelines, quality standards, GSFC standards, documents of other NASA Centers, Federal standards, military standards, and commercial standards.

The Contractor shall provide documentation services, including instrument conceptual designs, program plans, systems analyses, illustrations, technical and implementation plans, test plans, test procedures, test scripts.

The Contractor shall provide up-to-date drawings, specifications, certifications, reports, interface control documents, and agreements.

1. **Document Services Specific Task Orders** – The Contractor shall provide electronic media and document services, including:
 - a. Technical writing
 - b. Editing
 - c. Drafting
 - e. Photographic
 - f. Video
 - g. Reproduction
 - h. Compact Disc (CD), Digital Versatile Disc (DVD)
 - i. Posters and Displays
2. **Photo and Video Specific Task Orders** – The Contractor shall use photos and video for maintenance, engineering, or as documentation to explain a problem. They shall become supplemental to support system repair or future development and maintenance. A scale shall be included to indicate relative dimensions in photographs and/or video, where appropriate.

B. Education Services

The Contractor shall provide education services, including:

1. Supporting the AETD Systems Engineering Education and Development (SEED) program and Science & Engineering Collaboration Program (SECP) as well as the HQ System Engineering Leadership Development Program (SELDP).
2. Supporting educational outreach programs with universities and NASA headquarters.
3. Supporting MESAD and ISTD division or branch-level educational programs and training.

C. Standards and Process Services

The Contractor shall provide support for engineering standards work and engineering process work, including:

1. International Standard Organization (ISO) documentation and process generation.
2. Engineering standards documentation and review.
3. Engineering process documentation.
4. Activities in support of engineering process improvement.

This work shall include providing support for systems engineering capability assessment and improvement services, Task Ordering support of the Systems Engineering Working Group (SEWG), and Systems Engineering process improvement activities.

D. Configuration and Management Services

The Contractor shall provide overall management and oversight of the Configuration Management (CM), Documentation Management (DM), and Quality Control Management (QCM) disciplines throughout the life cycle for formulation and implementation of flight and ground systems provided within the scope of this Statement of Work. Each discipline shall require the development, establishment, and implementation of procedures and processes and establishment of mechanisms and tools for consistency.

The Contractor shall support the planning, identification of processes, and leading GSFC Project efforts in these disciplines. This support shall also include the necessary planning and associated process development for the GSFC Project in meeting conformance requirements to NASA procedures and guidelines as well as the ISO standards.

The main CM/DM/QCM functions shall include:

- Configuration identification, configuration control, configuration accounting and reporting
- Configuration verification and configuration auditing
- Implementation and maintenance of a DM system

The Contractor shall be responsible for providing the necessary tools and databases to accomplish the above functions; developing and establishing procedures and guidelines and training in the configuration management, documentation management, and ISO Q9001-2000 disciplines.

E. Demonstration, Presentation and Conference Services

The Contractor shall provide technology services for M&ISE demonstrations, technical/project/conference presentations, and conference planning/implementation for items within the scope of this Statement of Work, including:

1. **Demonstration Specific Task Orders** – The Contractor shall provide hardware, software, support equipment, and technical services for onsite and offsite demonstrations.
2. **Presentation Specific Task Orders** – The Contractor shall provide materials for inclusion in technical/project/conference presentations, including viewgraphs, information, photographs, etc. In addition, the Contractor shall perform the presentation.
3. **Conference Specific Task Orders** – The Contractor shall support the Government by providing services in the planning and implementation of conferences.

APPLICABLE DOCUMENTS AND SPECIFICATIONS

The contractor shall adhere to all applicable portions of the following documents and/or specifications in the performance of this contract. The latest updated version shall apply:

General:

NPR 7120.5, "NASA Space Flight Program and Project Management Requirements"

NPR 7123.1, "NASA Systems Engineering Processes and Requirements"

GPR 7123.1 "Systems Engineering"

SP-6105, "The NASA Systems Engineering Handbook, December 2007"

GSFC – STD – 1000, "Rules for the Design, Development, Verification and Operations of Flight Systems (GSFC GOLD Rules)"

Launch Vehicles:

AFSPCMAN 91-710, "Range Safety User Requirements Manual"

REFERENCE DOCUMENTS AND SPECIFICATIONS

The following documents and/or specifications are provided as reference material for the performance of this contract. The latest updated version shall apply:

Electro-Static Discharge (ESD) Control:

ANSI/ESD S20.20, "Protection of Electrical and Electronic Parts, Assemblies and Equipment" (excluding electrically initiated explosive devices)

300-PG-8730.6.1, GSFC Electrostatic Discharge (ESD) Control Plan