NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Ames Research Center
Entry Systems and Technology Division
Moffett Field, California 94035-0001

STATEMENT OF WORK
For
ENTRY SYSTEMS TECHNOLOGY RESEARCH AND DEVELOPMENT (ESTRAD)

October 1, 2014

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1.0 INTRODUCTION

The principal purpose of this contract is to provide support to the Entry Systems and Technology Division at NASA Ames Research Center to carry out their varied research programs. The branches within the Division that are supported by this contract include the Aerothermodynamics Branch (TSA), the Thermal Protection Materials Branch (TSM), and the Entry Systems and Vehicle Development Branch (TSS). These organizations work with other Ames organizations, NASA Field Centers, Government Agencies, and commercial entities to perform work within the scope of this requirement. Multidisciplinary, highly inter-dependent research and development is conducted across branch lines, making for highly inter-related task plans. The major objective of the organization is the development of technologies for use in the design and fabrication of prototype vehicles that travel at hypervelocities in the atmosphere of Earth and other bodies in the solar system, including access to Earth orbit and reentry, sustained high-altitude hypersonic flight, planetary entry, and high altitude aerocapture. Currently the division supports a variety of mission types and technologies including the Multi-Purpose Crew Vehicle (Orion); Mars 2020; Mars Entry, Descent, and Landing (EDL) Instrumentation; Heatshield for Extreme Entry Environment Technology (HEEET); Inflatable Aerodynamic Decelerator efforts; Propulsive Descent Technologies; Entry Systems Modeling; Science Mission Directorate Discovery and New Frontiers missions; and advanced technologies, such as nanotechnology, advanced materials, sensors, instrumentation, and devices. The Division maintains a customer focus and is committed to ensuring the transfer and use of its technologies by the commercial aerospace industry, the rest of NASA, other government laboratories, and academia.

2.0 SCOPE

The Contractor shall provide contract management functions, as well as multidisciplinary, highly inter-related scientific, engineering, and technical research and development services that support the projects of interest to the Division. This contract requires the Contractor to provide management for the work to be performed, to assure the availability of qualified personnel for timely response to requirements, and to manage all requirements. The technical requirements will be performed pursuant to Contract Task Orders (CTOs) issued by the Contracting Officer. These services shall include the necessary personnel, facilities, equipment, and materials (unless otherwise provided by the Government) to accomplish the tasks. The majority of the work will be performed on-site at NASA Ames Research Center, Moffett Field, California.

3.0 APPLICABLE DOCUMENTS

The Contractor shall comply with all current NASA Procedural Requirements (NPR) and Ames Procedural Requirements (APR) and Directives, including APR 7120.5 and NPR 7120.5, APR 7120.7, NPR 7120.7, APR 7123.1, and NPR 7123.1.

4.0 CONTRACT MANAGEMENT REQUIREMENTS

Effective contract management is essential to the successful execution of this contract. Overall contract management is a primary responsibility of the Contractor and will extend over the entire performance period of the contract. The Contractor shall:

4.1 RESOURCE TRACKING

Provide management and administrative functions necessary to manage and to track the labor hours, materials, and associated costs to perform contract management, and IDIQ task orders under this contract. This contract will require the simultaneous performance of multiple, interrelated tasks.

4.2 CONTRACT COMPLIANCE

Provide a management and administrative structure that provides a single point of contact for interface to the Contracting Officer (CO) and the Contracting Officer's Representative (COR). Provide procedures and management supervision to ensure compliance with applicable Government policies, regulations, and contractual requirements for all work performed under this contract.

4.3 WORKFORCE MANAGEMENT AND ALLOCATION

Provide overall management and oversight of all resources, facilitating the sharing of expertise as required across contract task orders. Plan, manage, control, and coordinate contract management requirements and technical task orders as issued by the Contracting Officer; manage the resources allocated by NASA for specific elements in a manner to ensure goals are reached in accordance with agreed upon milestones; and ensure that personnel assigned to elements have the training and expertise required for that element. The Contractor shall identify conflicting and/or complementary needs among task orders, and provide proposed approaches to leveraging resources, within ten working days of receipt of a task order, to ensure that conflicts are resolved and that needs are met.

4.4 WORKFORCE TRAINING

Ensure that all contract employees attend relevant training provided by the Government or required by the contract, prior to the due dates.

4.5 RISK MANAGEMENT

Ensure that the Government has adequate insight into the risks associated with the Contractor's ability to accomplish tasks. Include identification and mitigation of any risks with task order responses.

4.6 HEALTH, SAFETY AND ENVIRONMENTAL

Comply with the health and safety requirements contained in APR 8715.1 and NPR 8715, the system safety and mission assurance requirements in NPR 7120.5 (NASA Program and Project Management Processes and Requirements), environmental policies and procedures contained in NPD 8500.1, and Entry Systems and Technology Division processes and procedures.

4.7 QUALITY MANAGEMENT AND ASSURANCE

Participate with the Government to upgrade and maintain required plans, procedures, and work instructions in order to maintain the organization's compliance with any third-party quality assurance system and shall participate in any audits to maintain the quality system certification. Where the Contractor has primary responsibility for a functional or business area, the Contractor shall have primary responsibility for maintaining compliant documentation associated with that area.

4.8 GOVERNMENT PROPERTY MANAGEMENT

Provide property management to ensure accountability for installation-provided equipment and facilities and be responsible for annual inventory surveys and accountability verification forms.

4.9 TRAVEL MANAGEMENT

Provide management oversight of any short-term Contractor personnel travel that may be required to attend meetings, to participate in industry site visits, or to attend technical conferences. The Contractor shall budget for these expenses as well as anticipated publication expenses in the submission of the response to a task order or modification to a task order. The contractor shall coordinate contract employees' travel to conferences, field sites, universities, and other agencies in the performance of research, integration of products, technology development and infusion, and other important demonstration of results. All foreign travel by Contractors supporting NASA requirements must be completed following the policies and procedures of the Ames International Services Office and NFS 1852.242-71.

4.10 RESOURCE ACQUISITION

Acquire resources (equipment, supplies) as needed, not otherwise provided by the Government, to support the successful completion of all work.

4.11 STAFFING LEVEL MANAGEMENT

Be prepared to adjust the staffing level to accommodate the actual workload, i.e., hire and/or lay off staff as required within a reasonable time frame.

4.12 EMPLOYEE BACKGROUND CHECKS AND CLEARANCES

Ensure that all foreign national visitors and all employees have completed the required background checks, approvals, and clearance requirements for access to the NASA Ames Research Center.

Performance under this requirement will involve access to classified information, including attendance at classified meetings, up to a Department of Defense (DoD) or Department of Energy (DoE) level of "Secret".

5.0 TECHNICAL REQUIREMENTS

The Contractor shall be responsible for the successful performance of specific technical tasks. Aside from contract management, all other specific technical, scientific, and engineering requirements are categorized as Indefinite Delivery/Indefinite Quantity (IDIQ), as defined in individual CTOs. IDIQ assignments involve administrative, scientific, and engineering tasks designed to achieve a specific technical objective. These assignments and their associated schedules, milestones, and deliverables, are defined in individual CTOs. Specific objectives will be defined for each CTO according to the current and future needs of programs and projects involving the Entry Systems and Technology Division. The Contractor may be tasked to accomplish either an entire project from conception to operation, or a specific part of a project such as design or testing.

Since these tasks are internally funded by the requesting organization, contractor expense accountability must be accomplished on an individual task basis. The Contractor shall adhere to the performance measurements detailed in each CTO.

The following detailed requirements are included under the scope of the IDIQ technical, scientific, and engineering elements.

5.1 TECHNICAL OPERATIONS SUPPORT

The Division requires technical information management support for both project-related tasks and general support tasks. Administrative support is required to ensure that technical publications receive the necessary approvals and reviews, and that the Division web sites conform to NASA requirements for information release and ease of access. The Contractor shall provide the following specific support activities as required by the Government:

5.1.1 Technical Editing Services

Provide technical assistance for preparation of graphics and presentation materials including displays, posters, brochures, manuals, publications, presentations and website development.

5.1.2 Document Management

Manage the Division's archival records, publications, and other documents.

5.1.3 Operations Analysis

Provide support for the Division technical operations, including support to resource and workforce analysis, and provide interface to support data calls, and safety and mission assurance requirements.

5.1.4 Publications Services

Provide administrative support in the development of non-technical publications, such as marketing plans, strategic plans, and reports; control and preparation of forms and documentation; and management of laboratory and office supplies.

5.1.5 IT Support Services

Provide specialized computer system administration and software support necessary for the fulfillment of the research being performed under this contract with adherence to NPD 2810.1D, NASA Information Security Policy, and NPR 2810.1A, Security of Information Technology. Research office and laboratory space, computer hardware, and software, that are deemed necessary for the direct fulfillment of the task orders, will be provided by the Government.

5.1.6 Procurement Services

The Contractor shall, with CO approval and in accordance with the Subcontracts clause at FAR 52.244-2, support the potential purchase of any materials (consumables and non-consumables) necessary for the fulfillment of the task requirements.

5.2 TECHNICAL PROJECT MANAGEMENT SUPPORT

The Contractor shall develop program and project plans, provide expertise in team building, and provide planning, organizing, coordinating, monitoring, and managing projects including, but not limited to, the following:

5.2.1 Project Development

The Contractor shall provide support in all phases of project development. These tasks include: creating proposals documents, developing implementations plans and schedules, assessing project feasibility, and assessing technology readiness.

5.2.2 Project Implementation

The Contractor shall provide support for all phases of project implementation. These tasks include: performing trade studies and analyses, assessing project requirements, developing and assessing system architecture designs, refining project requirements and specifications, evaluating and refining project resource and schedule estimates and the basis of estimates, assessing implementation plans, performing system design and development, and developing risk assessment and management plans.

5.2.3 Project Monitoring

The Contractor shall provide support to assist NASA in monitoring project performance. These activities include: configuration management of critical project data; tracking milestones, schedules, budgets, and performance measurements; and performing cost control, contract/subcontract financial management, and resource allocations.

5.3 AEROTHERMODYNAMICS SUPPORT

Activities in this area include applied efforts in the aerothermodynamic analysis of current and future NASA launch vehicles, crewed spacecraft, and uncrewed planetary probes and Earth entry vehicles using in-house Computational Fluid Dynamics (CFD) and shock layer radiation codes, and in design activities in support of vehicle and mission studies that rely on aerothermal environment modeling in conjunction with Thermal Protection System (TPS) sizing and selection, trajectory trades, and overall vehicle performance/feasibility trades. Design efforts are supported through the integration and application of higher fidelity modeling early in the design process. Research is undertaken in studies of real gas physics in hypersonic, reacting gas flows, and development/implementation of new physical models into modern CFD and shock layer radiation codes and in the planning and implementation of flight experiments for aerothermodynamic research. Experimental efforts are conducted in the ballistic range and EAST facility to investigate fundamental hypersonic flow phenomena involving turbulent transition, shockwave radiation, etc. The results of these efforts are used to derive and assess numerical algorithm enhancements and modifications to existing in-house reacting flow solvers as appropriate based on the ongoing research/project requirements.

The Contractor shall be responsible for conducting research and performing applied analysis in the following areas.

5.3.1 Aerothemodynamics Model Development

The Contractor shall support the validation, optimization, and application of new Computational Fluid Dynamics (CFD) algorithms in support of thermochemical model development, including gas-phase kinetics, thermal nonequilibrium, transport, and surface chemistry models, that will allow the design, development, and certification of advanced Earth-to-orbit and planetary entry vehicles.

The Contractor shall also develop, validate and apply radiation heat transfer calculation methods for the simulation of shock layer and wake radiation for blunt body hypersonic flows.

5.3.2 Entry Vehicle Design Support

The Contractor shall support aerothermal environment prediction, and TPS sizing analysis and design for hypersonic vehicle development projects, such as the Orion crew vehicle, including the application of CFD methods and other modeling capabilities.

In addition, the Contractor shall perform systems analysis on vehicle systems to help guide investment of efforts in the Entry Systems and Technology Division, including support of design activities of the Center.

5.3.3 Experimental Capabilities Support

The Contractor shall perform calibration/validation experiments in concert with theoretical aerothermodynamics for the validation of thermochemical modeling efforts. They shall support the development and application of advanced, state-of-the-art, diagnostics for real-gas testing and data acquisition in shock tubes, ballistic ranges, and arc-jets. They shall design models for ballistic range testing and conduct experiments in the range. Finally, the Contractor shall develop and apply models for the simulation of the flow in high enthalpy facilities, for the characterization of facility capabilities and traceability of test conditions to flight.

5.4 ENTRY SYSTEMS AND VEHICLE DEVELOPMENT

The Entry Systems and Vehicle Development Branch (TSS) is responsible for performing and coordinating systems level integration for existing and future atmospheric entry vehicles. The TSS branch's primary role is the direct application of technologies and capabilities to analyze, design, develop, test, evaluate, manufacture, certify and operate atmospheric entry vehicles and systems. To facilitate the development of entry systems, the TSS branch performs systems level thermal performance, thermal-structural performance, induced and natural environment performance and manufacturing assessments. TSS pursues all phases of entry systems and vehicle development from early conceptual and preliminary designs, through detailed design, qualification and acceptance, to final certification, systems production and operations. A core capability of the TSS branch is systems analysis and systems engineering, including: requirements development, risk and reliability assessments, life-cycle cost assessment, configuration management, and verification and validation.

The Contractor shall provide support for various projects, including: design of inflatable decelerators; development of conformal ablator materials; design and testing of mechanically deployable entry systems; flight data evaluation; and general support for heatshield development. The specific areas of support include the following:

5.4.1 Systems Engineering and Design

The Contractor shall provide systems engineering support to develop heatshield designs, including the development of small probe heatshields for arc-jet test specimens, inflatable decelerator structures, and various flight test articles. They shall also support the design and build of large scale Manufacturing Design Units (MDU), and provide support for mission design studies.

5.4.2 Ground and Flight Testing

The Contractor shall support the assembly and instrumentation of small probe arc-jet test models. They shall also support the execution and post-test analysis of various ground tests.

5.4.3 Flight Data Reduction

The Contractor shall support planning data reduction from flight instrumentation to determine the heating and other conditions on the vehicle during flight, and development or improve any data reduction software as needed.

5.4.4 TPS Materials Development

The Contractor shall support the development of carbon fiber stitching techniques for emerging entry systems technologies.

5.5 NANOTECHNOLOGY

A nanotechnology group works within the Entry Systems and Vehicle Development Branch (TSS). This nanotechnology group performs fundamental research in nanoscience and nanotechnology and designs and develops nanoscale sensors, electronic devices, energy harvesting and storage devices and advanced materials. Efforts include growing or synthesizing nanomaterials, integration of nanomaterials into device architectures and characterization of the nanomaterial based devices. The Contractor may be required to provide support for research to determine the suitability of nanomaterial based devices to meet future NASA mission needs and establish a business case for their development and insertion into human and robotic exploration missions. NASA Mission Directorate end users for nanodevices will be identified and mission requirements and technology insertion plans will be developed with input from these end users. Specific projects may include:

5.5.1 Chemsensor Development

The Contractor shall support research to determine the suitability of carbon nanotube based chemsensor to meet future NASA needs. They shall also test the efficacy of existing chemsensor for detection of a variety of gas signatures critical in ECLSS applications, crew health diagnostics and detection of life on other planets.

5.5.2 Biosensor Development

The Contractor shall support research to determine the suitability of carbon nanotube and carbon nanofiber based electrochemical biosensor to meet future NASA needs, and test the efficacy of existing biosensor for detection of a variety of bio-signatures critical in ECLSS applications, crew health diagnostics and detection of life on other planets.

5.5.3 Nanoelectronics

The Contractor shall support research to develop nanoelelectronics, nanomaterial based printed electronics and sensor devices to meet future NASA needs, and develop methodologies and instrumentation to support in-space manufacturing of nanomaterial based electronics and sensor devices.

5.5.4 Energy harvesting and storage

The Contractor shall support research to develop nanomaterial based energy harvesting and energy storage devices to meet future NASA needs.

5.6 THERMAL PROTECTION MATERIALS AND SYSTEMS

Activities in this area include development, fabrication, testing (both ground and flight), and analytical modeling of advanced Thermal Protection System (TPS) materials and assemblies for hypersonic vehicles and spacecraft. These efforts include multidisciplinary work on flowfield/surface interactions, TPS/structural interactions, and analysis and instrumentation for flight and ground materials characterization and aerothermal heating tests. Basic research and technology development on advanced materials is also performed, in support of specific programs, such as crew exploration vehicles, planetary probes, fundamental aeronautics, and sample return missions. The organization leads materials

development activities that cover the spectrum of Technology Readiness Levels (TRL) from 1 to 6 (NPR 7120.8, Appendix J), and sometimes participates in activities to increase material technologies from TRL 6 to 9. Support also includes the operation and maintenance of experimental and laboratory facilities. Specific requirements for the thermal protection materials and systems support include:

5.6.1 TPS Materials Development

Pursue development of advanced reusable and ablative TPS materials, including ceramic composites, ceramic/polymer composites, rigid and flexible TPS, insulations, coatings, and surface treatments. Material samples will be fabricated and tested to determine the optimum processing conditions. Optimization will consider material performance, fabrication safety, cost and other factors. Develop and document material processing specification.

5.6.2 Lab Management

Manage operations in the materials development and materials characterization labs, including scheduling the maintenance, repair, and calibration of lab equipment. The equipment includes a scanning electron microscope (SEM), IR spectrometer, X-Ray diffraction unit, energy dispersive X-Ray analyses unit, inductively coupled plasma spectrometer, laser particle size analyzer, thermogravimetric analyzer, side-arm reactor, and other general lab equipment and fixtures. Investigate new lab equipment acquisitions.

5.6.3 Material Characterization Services

Perform material characterization tests as required in support of materials development research and project activities. This work includes, but is not limited to, measurement of material composition, thermal and mechanical properties, SEM imaging of microstructures, decomposition chemistry kinetics, and surface optical properties.

5.6.4 Test Model Fabrication Services

Fabricate, modify, and inspect TPS material samples for ground testing and flight. Design and fabricate instrumentation to measure material performance in both ground tests and flight. Machine metals and ceramics, spray coatings, apply adhesives, and work with flexible insulation as needed. Travel may be required to install, repair, and inspect articles off site.

5.6.5 Material Test Operations Services

Provide test engineer support for materials testing in the arc-jet complex. Activities include all aspects of testing, such as development of test plans, coordination with test facility operators, evaluation of test feasibility, design of test models and instrumentation, and managing pre- and post-test analysis.

5.6.6 Thermal/Mechanical Analysis Services

Apply computational tools to analyze the thermal and mechanical response of TPS materials, components, and assemblies for both ground test models and flight designs under various reentry loads. Commercial software, such as MSC.Nastran and MSC.Marc, may be used in these analyses.

5.6.7 Material Response Modeling

Apply exiting ablating material response computational tools to predict the performance and thickness requirements of TPS materials, under both ground test and flight heating environments. This work utilizes in-house material response codes, FIAT and 3D-FIAT, written primarily in FORTRAN. Develop new software routines to improve the modeling fidelity of existing material response tools, and create new tools as necessary. Support efforts to develop software tools to analyze coupled CFD and material response behavior.

5.6.8 Engineering Design Services

Provide engineering design support for development of arc-jet and other test models, and flight hardware. These tasks require the use of computer aided design software, such as SolidWorks and ProE. Design engineers are also required to coordinate with test principal investigators and other project support staff, and good communication skills are essential.

5.6.9 Computational Materials Services

Provide support for computational materials research by developing first-principles approaches for prediction material properties and performance. This research uses in-house developed software and other existing software tools to model material behavior from the atomistic level to the continuum level. Additional activities include the development of research plans, and coordination and cooperation with other researchers and project managers.

6.0 ASSOCIATED FACILITIES

Facilities and labs which may be used during performance of this contract include, but are not limited to:

- Electric Arc Shock Tube (EAST)
- Ballistic Range Complex
- Arc-Jet Complex
- Sensor & TPS Advanced Research (STAR) Lab
- Materials Development Lab
- Materials Characterization Lab
- Nanotechnology Labs

7.0 DELIVERABLES AND REPORTS

Contract deliverables and reports are identified and described in the Contract Data Requirements List attachment to this contract. Task specific deliverables will be defined in the CTOs.

8.0 PHASE-IN AND PHASE-OUT

8.1 PHASE-IN

The phase-in process shall be accomplished as expeditiously as possible, with a maximum phase-in period of 30 days. 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 operation requirements. The incoming contractor is responsible for providing a qualified contractor staff by the end of the phase-in period.

8.2 PHASE-OUT

The Contractor is responsible for the orderly transfer of duties and records, including complete equipment and systems, to the incoming Contractor or NASA, if there is no successor contract. This shall be accomplished in an expeditious manner, consistent with the phase-in schedule, while precluding interruption of the scheduled performance of the activities in ongoing Task Orders. During Phase-out, the Contractor shall have transferred all records and documentary material in an orderly manner and vacated all areas of Contractor responsibility, having left them in a clean, professional state and having completed

the check-out process. The Contractor shall submit a phase-out plan no later than 60 days before the end of the contract for government review and approval.