STATEMENT OF WORK
FOR
AERONAUTICS AND EXPLORATION
MISSION MODELING AND SIMULATION (AEMMS)

1.0 INTRODUCTION

The principal purpose of this contract is to provide support to research and development activities of the Systems Analysis Branch of the Flight Vehicle Research and Technology Division, the Aeromechanics Division of the Army Aviation & Missile Research, Development & Engineering Center's Aviation Development Directorate, and the Applied Modeling and Simulation Branch, and the Fundamental Modeling and Simulation Branches of the NASA Advanced Supercomputing (NAS) Division (hereafter known as the Requesting Organizations). This document describes the current and anticipated research programs of the organizations. The major objectives include the development and application of technologies for the design and analysis of aerospace vehicles and systems, large-scale numerical simulations in support of NASA and Army mission critical engineering applications, and fundamental advances in numerical methodologies, algorithms, physical models, and application code development.

2.0 SCOPE OF WORK

2.1 GENERAL SCOPE

The scope of the effort to be performed within this contract is described in this section.

The Contractor shall provide fundamental and engineering research and development, pursuant to contract task orders issued by the Contracting Officer. These services shall include the personnel, facilities, equipment and materials (unless otherwise provided by the Government) to accomplish the tasks.

Task assignments will be issued to perform services in the following areas: project management, systems engineering, systems analysis, research and analysis, design and development, testing, computer modeling, technical writing, computer systems administration, administrative services, and other functions necessary to complete projects. The Contractor shall provide management and administrative functions necessary to effectively and efficiently manage the work performed under this contract.

The Contractor shall perform services to enable the modeling, simulation, and analysis of systems relevant to the NASA aeronautics, exploration, space operations and science missions as required by task order in the following technical areas:

a) Aerospace systems analysis tools development and application
b) Aerospace vehicle and system design, analysis and optimization
c) Computational Fluid Dynamics (CFD) and Computational Structural Dynamics (CSD) tools development and application
d) High fidelity modeling and simulation of aerospace vehicles and systems
e) Development of improved physical models

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f) Integrated multidisciplinary design and analysis framework development
g) Risk analysis methods development and application to aerospace systems
h) Geometry and Grid generation tool development
i) Planetary and Earth Science modeling
j) Modeling and simulation of “green” technology applications
k) Optimization and mission decision support tools and analysis
l) Computational chemistry, computational biology, and computational material science
m) Integrated multidisciplinary design and analysis of aerospace vehicles

Specific requirements will be defined for each task order according to the current and future needs of programs and projects involving the requesting organizations. 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.

2.2 CONTRACTOR RESPONSIBILITIES

The Contractor's responsibilities shall include the management of personnel, timely and effective implementation of task assignments, monitoring of any applicable subcontract performance, management of scheduled deliveries, and timely and effective reporting to the Government. These responsibilities shall also include efficient cost and risk management methods as well as procedures to ensure that the Government is aware of task assignment status and progress achieved. Management includes managing financial and personnel resources as well as conforming to established NASA policies and to budgetary guidelines. Most of the work will be performed on-site at Ames Research Center (ARC), Moffett Field, California.

The Contractor shall 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 system and shall participate in any audits to maintain the quality system compliance/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.

The Contractor shall provide qualified management personnel, organizational structure, procedures and administration support functions to effectively and efficiently manage the work performed under this contract. The management and administrative structure shall provide a single point of contact for interface to the Contracting Officer's Technical Representative (COTR) and shall provide procedures and management supervision to ensure compliance with applicable government regulations for accomplishing this contract.

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 assignments. The Contractor must have the flexibility to hire personnel at all appropriate levels of skills and experience, including, but not limited to, administrative staff, university students, post-docs, junior and senior research scientists and engineers. The Contractor will support the Requesting Organizations’ goals to acquire a highly skilled workforce that is aligned with NASA missions and continues to value intellectual

advantage and synergy that is made possible by a diverse workforce. The Contractor will 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 property.

The Contractor shall provide computer system administration support necessary for the fulfillment of the work of this contract, when tasked by the Government. This work shall include on-site IT support services for desktop, laptop, workstation, and server computers.

Research office and laboratory space, computer hardware, and software, deemed necessary for the direct fulfillment of the task orders will be provided by the Government. The Contractor may purchase, with COTR approval, and in accordance with the Subcontracts clause at FAR 52.244-2, any materials (consumables and non-consumables) necessary for the fulfillment of their task requirements.

The Contractor shall comply with the health and safety requirements contained in APR 1700.1 and the system safety and mission assurance requirements in NPR 7120.5, NASA Program and Project Management Processes Requirements, and applicable processes and procedures of the Requesting Organizations.

The Contractor shall comply with software engineering requirements in accordance with:

NPR 7150.2A, NASA Software Engineering Requirements

APR 7150.2, Ames Software Engineering Requirements

The contractor shall also support educational outreach and internship opportunities from high school to doctorate levels to support NASA programs, to provide students with exposure to public service and enhancement of their educational experience.

3.0 REQUIREMENTS

3.1 GENERAL

3.1.1 Technologies

Research and Development in the Systems Analysis Office focuses on the development, test, application and evolution of computational modeling and simulation tools and technologies for system and vehicle conceptual analysis and design. In support of the aeronautics and space exploration missions, the branch develops tools and integrated processes to enable new analysis methods in support of technology portfolio, vehicle, and mission analysis. Technologies and tools using high end computing for mission simulation and vehicle design are developed for, and applied to, advanced aerospace vehicle and system concepts.

The NAS Division develops CFD/IT/Physical modeling and Computational Chemistry technologies to support the Human Exploration, Aeronautics, Space Operations and Science Missions. Emphasis is on tool development and analysis of mission enabling technologies and engineering applications on NAS High End Computing (HEC) systems. Applications are varied and evolving with the new NASA Exploration and Science

missions. Flow regimes range from incompressible through hypersonic velocities. There is a constant need to develop new computational tools and risk assessment methodologies to improve the modeling and analysis capabilities in support of these missions.

The Army Aviation Development Directorate develops and applies tools for the computational simulation of rotorcraft, including codes to model rotor aerodynamics and methods for the coupling of computational fluid dynamics with computational structural dynamics.

The NASA Aeromechanics Office is responsible for aeromechanics research activities that directly support the civil competitiveness of the U.S. helicopter industry. The work will support the Aeronautics Research Mission Directorate (ARMD) and the Fundamental Aeronautics Program, through the Rotary Wing Project. This work will address all aspects of the rotorcraft which directly influence the vehicle's aerodynamic performance, structural, and dynamic response, loads, external acoustics, flight dynamics and control, handling qualities, vibration, and aeroelastic stability. The work to be performed is both theoretical and experimental in nature, including the development of new technologies and new vertical lift aircraft concepts.

3.1.2 Customers

The Systems Analysis Office develops and applies technology in support of numerous government and industry customers. Support to the Aeronautics Research Mission is provided to the Environmentally Responsible Aviation project to perform computational aerodynamics and aero-acoustics analyses of advanced transport aircraft systems in support of wind tunnel test planning and post test analysis. Under the Aeronautical Sciences project, the office is developing and applying integrated multi-disciplinary analysis and optimization tools and processes. And in conjunction with the Airspace Systems program, models of advanced aircraft types are being developed for integration with airspace systems analysis models. In support of the Human Exploration Mission and the Space Technology Mission, entry vehicle research and analysis is provided with aerodynamic and aerothermodynamic analysis of exploration vehicles including the Orion Multi-Purpose Crew Vehicle (MPCV), decelerator concepts and planetary entry vehicles for space science, supporting the design of thermal protection systems and providing aerodynamic performance models for descent and landing. Cross-cutting support is provided to a variety of Agency studies addressing missions such as Mars entry and sample returns; and to design efforts with Industry and Other Government Agencies for aircraft and space flight vehicles including “green” aircraft technology development and Lighter than Air (LTA) vehicle and mission design and analysis.

NASA Advanced Supercomputing (NAS) Division supports the Human Exploration and Operations Mission Directorate (HEOMD) and the Aeronautics Research Mission Directorate (ARMD). This involves a wide range of research and application work. Examples mostly include high-fidelity CFD simulations to support qualification for flight and shuttle debris analysis, SLS design analysis and database generation, complex simulations of the shuttle flame trench, and flame propagation within the shuttle vehicle assembly building, rotorcraft simulations, and green technology simulations and risk assessment in support of SLS and commercial crew program and partners.

Development of new technologies to automate grid generation, solution submission, and data reduction/post-processing is also carried out in support of all three missions. Project work often includes rapid response to complex problems with short time-frames for deliverables.

Work in the NAS division also includes fundamental research in the areas of rotorcraft, fixed-wing subsonics, supersonics, and hypersonic flight vehicles. Examples include numerical algorithms, new enabling technologies, and physical models to improve the efficiency and accuracy of CFD and computational chemistry simulations for NASA mission applications. These methods are developed for inviscid and viscous flows ranging from incompressible to hypersonic flight conditions. Numerical algorithm development and application codes include Euler, RANS, Detached-Eddy Simulations, Large-Eddy Simulations, and Direct Numerical Simulations.

The Army Aviation Development Directorate is chartered with the development and application of advanced rotorcraft modeling and simulation capabilities in support of Army aviation.

The NASA Aeromechanics Office is chartered with the development and application of advanced rotorcraft experimental, modeling and simulation capabilities, and the development of new technologies and vertical lift aircraft concepts in support of the U.S. helicopter industry.

3.2 SPECIFIC REQUIREMENTS

3.2.1 Integrated Analysis Environments

3.2.1.1 General

This area may include:

Development of data models, user interfaces and integrated tools and models in support of aircraft, exploration, and planetary entry vehicle design and analysis. Existing and new tools and frameworks will be applied to the development of computational models for aeronautical systems such as advanced transport, Unmanned Aircraft Systems (UAS), Lighter than Air (LTA) vehicles; ground-based and aerial launch systems; and entry, descent and landing systems. The task will include gap analysis to identify requirements for new tools, tool integration, tool modification, and/or tool validation and, with prioritization from government task requestors, further development activities will be driven by this analysis.

Test and integration of vehicle and system analysis and design environments.

Development of data specification structures including the development of application-specific data ontologies, data structure development, and the integration of the structure with analysis codes and frameworks.

Development of multi-fidelity tool integration capabilities, cross-framework integration processes, and process management techniques.

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3.2.1.2 Contractor Responsibilities

The Contractor shall be responsible for conducting research and development in the areas described above. Example specific problem areas are given as follows:

a) Support gap analysis to identify requirements for new tools, tool integration, tool modification, and/or tool validation to enable the activities listed in (b).

b) Support in the development, test, and integration of new tools to improve design and analysis of atmospheric flight, launch, and entry vehicles concentrating on the disciplines of aerodynamics, aerothermodynamics, structures and fluid/structures interaction, trajectory, weights and sizing, and TPS sizing.

c) Define and develop integration methods for multi-fidelity processes, including software integration within existing frameworks (e.g., Model Center), and data integration methods.

d) Support in the identification of analytical gaps and requirements for experimental code validation for hypersonic and supersonic decelerator analysis.

e) Support the development of decelerator design and analysis capabilities.

f) Develop and demonstrate methods to integrate engineering level tool processes and frameworks with NAS supercomputers and other cluster environments to enable the integration of high fidelity and parallelized codes within the analysis framework.

g) Develop and validate analysis process management capabilities to enable the selection of appropriate tools and input conditions, given a database of benchmarked tool results across a range of configurations and flight conditions.

h) Develop risk models and risk analysis tools for launch vehicles, exploration vehicles and subsystems, planetary entry vehicles and subsystems (e.g., TPS), and exploration architectures.

3.2.2 Aerospace Vehicle and System Design and Analysis

3.2.2.1 General

This area includes:

• Design and development of vehicle and system concepts for exploration and aeronautics missions.

• Design and development of vehicle and system concepts in support of Industry and Other Government Agency requirements for aircraft, space flight, and planetary entry vehicles.

• Performing technology and system trade studies.

• Development and application of mission performance and risk analysis methods.

• Development and application of mission modeling and simulation capabilities to perform multi-fidelity analysis to predict system performance characteristics and risk profiles.

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3.2.2.2 Contractor Responsibilities

The Contractor may be required, by task order, to provide the following support:

a) Perform vehicle and systems analysis for aeronautics vehicles and systems including the integration of their flight characteristics with the airspace architecture.

b) Develop revolutionary concepts for aeronautics in pursuit of NASA goals and objectives for the aeronautics mission. Provide trade studies, and cost and benefits analysis of these concepts. Identify critical revolutionary technologies that will be required to develop these concepts.

c) Perform vehicle and systems analysis for launch, entry, and descent of exploration and space science missions.

d) Develop and apply new engineering and CFD methods and processes in support of aeronautics and space vehicle/system multi-disciplinary, multi-fidelity analysis and design.

e) Develop and validate new engineering and CFD capabilities as required to support the design and analysis of space, atmospheric flight, and planetary entry vehicles.

f) Develop aerodynamic databases for aeronautics and space flight vehicles. Document best practices for application and set up of CFD codes for different configurations and flight conditions.

g) Develop and apply modeling and analysis capabilities for aerodynamic, aero-acoustic, structural, controls and fuel burn characterization of advanced aeronautics vehicles.

3.2.3 Computer System Administration

3.2.3.1 General

Support branch requirements by providing PC systems administration for Windows, Mac and Linux operating systems. Provide regular backups, troubleshoot system problems, perform set-up of new equipment, and update systems as required with all cognizance of and adherence to NASA and NAS IT Security requirements and processes. Oversee use of the Branch model-building machine, identifying requirements for maintenance, new materials, etc.

3.2.3.2 Contractor Responsibilities

The Contractor shall be responsible for developing and supporting technology portfolio analysis and management capabilities. Example specific requirements include:

a) Provide regular backups, troubleshoot system problems, perform set-up of new equipment, and update systems as required.

b) Maintain cognizance of and adherence to NASA IT Security requirements and processes. Communicate regularly to branch management and personnel regarding security requirements and their impacts.

c) Support installation and testing of AUS Linux server and associated compute nodes.

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Provide installation support for COTS and in-house codes, maintaining configuration control over cluster-installed codes.

3.2.4 NAS Division Requirements

3.2.4.1 General

A portion of this task is involved in the development, validation, and application of CFD and engineering risk tools involving the Space Launch Vehicle (SLV), Commercial Crew Program and collaboration with Commercial Crew Program partners. Fundamental research in support of these programs/missions as well as those in the Aerodynamic Research Mission Directorate is also pursued.

Areas of current and future activity include, but are not limited to:

- Computational Fluid Dynamic (CFD) algorithm and tool development
- Space Vehicle Launch and Ascent Analysis
- Space Shuttle Analysis
- Development and application of analysis tools in support of advanced rotorcraft design
- Development of automated CFD parameter-study tools
- Planetary and Earth Science CFD modeling
- Modeling and Simulation of green technology applications
- Computational chemistry modeling
- Engineering Risk Assessment

3.2.4.2 Contractor Responsibilities

a). Adjoint-Based Mesh Optimization Frameworks for Cart3D

This subtask focuses on employing the Cart3D adjoint module for use in shape optimization with Cart3D.[4][5] Work in this period focuses on using error information from the solution of the discrete adjoint to guide mesh adaptation within the design cycle. This work includes investigation into the control of discretization error in gradient-based aerodynamic shape optimization through use of adaptive mesh refinement with the goal of dynamic mesh adaptation as design progresses. This effort should focus on examples relevant to ARMD Fundamental Aeronautics High Speed and Fixed Wing subprojects. Theoretical development should focus on formulation of a functional appropriate for automatic error control in design and on implementation of a basic strategy for progressive optimization, where the depth of mesh refinement is systematically increased as the design improves. All theoretical development should be accompanied by clear and extensive documentation of the method and its implementation.

b) Modeling and Simulation Support for Launch and Ascent Vehicle Analysis (LAVA) including Ground Operations

This task involves Computational Fluid Dynamics (CFD) work to deliver inviscid and viscous simulations of Space Launch Systems (SLS), SWORDS and Commercial Crew configurations within strict deadlines. This work includes

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generation of grid scripts to create viscous overset grid systems, while accommodating changing vehicles and geometries. Responsible for setup, execution, and analysis of large aerodynamic databases for rocket ascent, buffet loads, and stage-separation events, as well as launch pad environment and research problems. This task also involves evaluation of computational methodologies for the prediction of ignition overpressure (IOP), noise generation, and acoustic propagation during lift-off of space launch vehicles. Duties include performing spatial and temporal resolution studies of launch vehicles during lift-off in order to determine the computational requirements for accurate IOP/aeroacoustic simulations. In addition to characterizing the resolution requirements for lift-off simulations various modeling assumptions must be analyzed. These include examining the effects of different turbulence modeling assumptions, such as RANS and DES. Assistance in expanding prediction capabilities of LAVA solvers, developing pre- and post-processing tools, performing spectral and POD analysis might be additional requirement for this task. In vehicle aerodynamics activities of LAVA, duties will be CFD support to Fundamental Aerodynamics (FA) High Speed (HS) and fixed wing project (FW), Environmentally Responsible Avionics (ERA) subsonic fixed wing and high speed projects, SOFIA, RSAA activities, and additional upcoming projects related to vehicle aerodynamics. Duties include preparing CFD ready OML from a given CAD file, develop/expand/use pre-post-processing, utilizing Cart3D, OVERFLOW, STAR-CCM+, and suites of LAVA solvers. This subtask is expected to require four full time position during the current performance period.

c) Design Analysis for Large Civil Tiltrotor 2nd Generation (LCTR2)

The purpose of this subtask is to perform proof of concept 3-D flow analysis and design for the LCTR2 (Large Civil Tilt Rotor 2) blade in hover and forward flight mode. The task will employ the rotorcraft mode of the 3-D Navier-Stokes code, OVERFLOW2 and the Comprehensive code (CAMRAD II) coupling capability in the finite-difference design process to support the three-dimensional (3-D) design of LCTR2 blades in Code AUA. The main emphasis of this sub-task is to complete an analysis of the feasibility of using large scale 3D Navier-Stokes simulations in a finite-difference gradient optimization design process.

d) Commercial Crew Transport Risk Studies

Support the performance of crew safety assessments in support of the Commercial Crew Support the performance of crew safety assessments in support of the Commercial Crew Program. The work focuses on continued development and application of a GoldSim dynamic simulation model and the Ames Reliability Tool for engineering risk assessment of a number of proposed launch vehicle/crew vehicle architectures. Results will include ascent, on-orbit, and EDL mission phase assessments, including key risk driver and sensitivity identification. A generic case study will be developed, likely to be based on a available commercial launch vehicles, to provide a focused demonstration of the new model. Wherever possible, the model should be parameterized in such a way as to allow the user to vary parameters as necessary to represent different vehicle architectures and missions. The adaptation of the risk model will also require coordination with personnel developing physics-based models to ensure appropriate interfacing of the failure inputs. The team will be responsible for completing risk analyses, documenting results and delivering/presenting these results to the customer.

It is expected that additional space exploration systems will be assessed, such as the Space Launch System (SLS), SWORDS, or Aquila II architectures, and risk modeling for these systems will be required. Models will be constructed, data synthesized to populate the models, and results documented and presented to partner teams.

e) Coupled Aero-structural Simulations with Cart3D

This subtask focuses on development of structural deformation loosely-coupled aero-structural solutions using the Cart3D analysis package aimed at supporting multidisciplinary optimization (MDO). Work will focus on incorporation of static structural deformation due to simulation-based estimates of flight loads and producing a preliminary aero-structural module for use with Cart3D. This module should include a clearly defined interface to the structural model and aero package so that alternative packages can be explored. This effort should focus on examples relevant to ARMD Fundamental Aeronautics High Speed and Fixed Wing subprojects. All theoretical development must be accompanied by clear and detailed documentation of the methods and their implementation. Software must be written for supportability and developed in collaboration with other team members, and must be compatible with both the Cart3D analysis package and aero-design framework.

3.2.5 Computational Fluid Dynamics Applications for Rotary-Wing Vehicles

3.2.5.1 General

Computational simulations of rotor aerodynamics require models for the discrete rotor blades including relative motion between the main rotors, plus the fuselage and tail rotor. These types of calculations involve high-resolution multiple overset grids and small time steps to capture the details of the interactional aerodynamic forces and rotor wake. These calculations also typically involve coupled structural deformations of the rotors and fuselage.

The Army Aviation Development Directorate has teamed with the High Computational Research and Engineering Acquisition Tools and Environments Air-Vehicles (CREATE-A/V) Program to jointly develop high-fidelity modeling and simulation software tools for rotorcraft aeromechanics. The 12-year DoD CREATE-AV program was established in FY2008 with a charter to develop high-accuracy computational analysis software to improve the DoD acquisition engineering design process.

Within this CREATE-AV umbrella, the AFDD has recently released version 4 of its "Helios" software product that provides high-fidelity, physics-based computational aeromechanics modeling for rotary-wing vehicles. Version 4 of Helios provides modeling capability for multiple rotors and rotor-fuselage combinations with aeroelastic deformations of the rotor blades.

The new Helios software performs coupled rotorcraft CFD/CSD analysis with improvements in speed, accuracy, and throughput compared with the legacy software tools such as NASA’s OVERFLOW code. The Helios goal is to transform the analysis-test paradigm that currently exists within the domestic rotorcraft industry to one built

around high-performance computing.

This new Helios software package uses either structured or unstructured-grid CFD codes for the near-body flow solver, a uniform Cartesian off-body flow solver, plus a new rotor dynamics and trim model that is truly scalable. The Army Aviation Development Directorate needs software developers, software testers, and software quality control experts for this new code development project.

3.2.5.2 Contractor Responsibilities

The Contractor shall be responsible for conducting research in the areas described above. Example specific problem areas are given as follows:

a) Apply the Helios aeromechanics analysis software to analyze specific Army and NASA rotorcraft problems. These applications will entail both structured and unstructured overset-grid generation for practical rotary-wing fuselages and rotor systems such as the Army's CH-47 Chinook and the UH-60 Blackhawk helicopters.

b) Develop scaleable finite-element computational analysis methods for rotor dynamics and trim. These rotor dynamics and trim models must integrate with the overall Helios CFD/CSD framework for rotor aeromechanics.

c) Take responsibility for software quality control, testing, and evaluation of the new Helios code during its multi-year development cycle.

d) Develop and apply tools and processes for rotorcraft signature modeling and effectiveness analysis.

3.2.6 Rotorcraft Aeromechanics Research and Development

3.2.6.1 General

The objective of this effort is to research, develop, apply, and validate advanced computational methodology research using computational fluid dynamics, multi-disciplinary comprehensive analyses, advanced flight dynamics and control methodologies, and rotary wing preliminary design processes. Experimental research seeks to obtain accurate data to validate these analyses, investigate phenomena currently beyond predictive capability, and to achieve rapid solutions to flight vehicle problems, including pilot-in-the-loop research. Databases from the flight and wind tunnel experimental programs are validated, documented and maintained for the benefit of the U.S. rotorcraft technology base.

3.2.6.2 Contractor Responsibilities

The Contractor shall be responsible for conducting research in the areas described above. Example specific problem areas are given as follows:

a) Develop and apply advanced computational methodology in CFD, multi-disciplinary analyses, advanced flight dynamics and controls, and experimental methodologies for rotary wing preliminary design processes.

b) Perform technology exploration, transfer, and transition in high risk, pre-competitive rotorcraft technology research areas.

c) Perform rotary wing component testing, developing high quality data acquisition and measurement systems as required.

3.2.6 Travel

Contractor personnel may be required to travel for short periods of time to attend meetings, to participate in industry site visits, or to attend technical conferences. The Contractor will 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.

3.2.7 Contract Task Order Accounting – Move to Deliverables

Since tasks are internally funded by the ARC requesting organization, contractor expense accountability must be accomplished on a task basis.

3.3. PERFORMANCE MEASUREMENT

The Contractor shall adhere to the performance measurements detailed in each task order.

4.0 DELIVERABLES AND REPORTS

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

5.0 EMERGENCY PREPAREDNESS AND RESPONSE

The Contractor's obligation may include resolution of unusual or emergency situations. The Contractor may be required to assist NASA, within the general scope of work, but in currently unidentified ways, in preparation for, or in response to emergencies. Obligations under this requirement shall only arise when one or more of the criteria at FAR 18.001, enabling NASA to utilize "Emergency Acquisition Flexibilities", are met. If the emergency preparedness and response requirements result in changes to the contract, all contract adjustments will be processed in accordance with the Changes clause of this contract.

6.0 SYSTEM SAFETY, RELIABILITY, AND QUALITY ASSURANCE

The contractor shall interface and coordinate with the NASA ARC Safety, Environmental and Mission Assurance Directorate for defining and implementing safety, reliability, and quality assurance requirements.

In support of CTOs issued, the Contractor shall comply with, and be an integral part of the Ames Management System. This includes following applicable Ames' procedures that are subject to audit. The Contractor shall attend relevant training, provided by the Government, as required for all on-site employees. Specific procedures will be indicated on each task order response. These procedures include, but are not limited to, the following AMS documents:

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NPD 1280.1A NASA Integrated Management System Policy
APR 1280.1 Ames Management System (AMS) Quality Manual
NPD 8730.5 NASA Quality Assurance Program Policy

The Ames' Quality System documents can be found at: http://ams.arc.nasa.gov

7.0 PHASE-IN AND PHASE-OUT

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.

Phase-Out: Upon completion of this contract, the outgoing contractor is responsible for the orderly transfer of duties and records to the incoming contractor. This should be accomplished in an expeditious manner, consistent with any contract phase-in schedule, while minimally impacting ongoing task orders. The contractor shall submit a phase-out plan no later than 60 days before the end of the contract for Government review and approval.

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