

**ATTACHMENT J-1**  
**STATEMENT OF WORK  
FOR  
AVIONICS SIMULATION SUPPORT**

**1.0 Scope**

The Contractor shall provide specialized engineering support to the Flight & Ground Software Division and the Systems Development, Integration & Test Division of the Engineering Directorate, Space Systems Department. The Contractor shall provide support for, but not limited to, the Constellation Program (CxP), ARES Project, other launch and space system products, and Automated Rendezvous and Capture (AR&C) projects, tasks and activities for the National Aeronautics and Space Administration (NASA) at the Marshall Space Flight Center (MSFC).

The Marshall Space Flight Center's avionics integration and simulation capabilities provide for sophisticated non real-time all-digital simulations, real-time Hardware-in-the-Loop (HWIL) simulations, and geographically distributed simulations. These capabilities support the development and test of experiments, subsystems, spacecraft control systems, and complete launch vehicle systems. These capabilities test and evaluate integrated flight/vehicle control systems (flight computer, Guidance, Navigation, and Control (GN&C) components, actuator control systems, etc.), vehicle GN&C algorithms, flight software, sensors, and effectors.

The Contractor shall support the design, development, test and evaluation of models and simulations. The Contractor shall support the design, development, and implementation of geographically distributed simulations. The Contractor shall support the design, development, test and evaluation for avionics integration assets. The Contractor shall support the design, development, test and evaluation for integrated avionics system assets.

The Contractor shall support the development and test of man tended and Autonomous Rendezvous and Capture (AR&C) systems. These capabilities test and evaluate integrated flight/vehicle control systems (flight computer, GN&C components, actuator control systems, etc.), rendezvous and capture system components, rendezvous sensors, vehicle GN&C algorithms, flight software, manipulators, attachment systems (docking and berthing mechanisms), and autonomous control system architectures.

The Contractor shall participate in various Technical Working Group (TWG) meetings, interface with the System Integration Groups (SIGs), and participate in monthly reviews and / or telecons to collect the required information for supporting these task processes. The Contractor shall support the MSFC Engineering Directorate in providing data, documentation and information to meet program reviews and schedules as required.

## **2.0 Task Order Management and Reporting**

### **A. Contractor Management**

The Contractor shall provide the planning, coordination, technical direction, and surveillance of the activities necessary to assure disciplined performance of work and timely application of resources for the accomplishment of all tasks issued under the order. The Contractor shall be responsible for maintaining communication with each supported organization and alerting the Contracting Specialist immediately of any problems that would prevent meeting established milestones.

The Contractor shall report and document this work and fulfill the requirements of associated Data Requirement Descriptions (DRD's) as outlined in Data Procurement Document (DPD) 1268 (Attachment J-2). The contractor shall determine the data restriction that applies to each data deliverable and mark or transmit the data restriction in accordance with section 2.3.3 of the Data Procurement Document.

### **B. Data Requirements Descriptions (DRDs)**

The contractor shall prepare and maintain a report identifying and listing all equipment, tools, etc., provided by the Government for use by the contractor in the performance of contracted effort, and for which the contractor has been given physical custody. This plan shall be prepared and maintained in accordance with DRD 1268LS-001.

The Contractor shall prepare and deliver a Badged Employee and Remote IT User Listings in accordance with DRD 1268MA-001.

The Contractor shall prepare and deliver a Contractor Employee Clearance Documents in accordance with DRD 1268MA-002.

The Contractor shall prepare and deliver a Position Risk Designation for Non-NASA Employee in accordance with DRD 1268MA-003.

The Contractor shall prepare and deliver a Monthly Progress Report in accordance with DRD 1268MA-004.

The contractor shall establish and implement an industrial safety, occupational health, and environmental program that (1) prevent employee fatalities, (2) reduce the number of incidents, (3) reduce the severity of employee injuries and illnesses, and (4) protects the environment through the ongoing planning, implementation, integration and management control of these programs in accordance with DRD 1268SA-001. The SHE Plan shall address each of the following MSFC SHE core program requirements in detail that are applicable to the contracted effort:

- a. Management leadership and employee involvement.
- b. System and worksite analysis.

- c. Hazard prevention and control.
- d. Safety, health and environmental training.

The Contractor shall report mishaps and safety statistics to the MSFC Industrial Safety Branch in accordance with DRD 1268SA-002. The contractor shall submit direct to the NASA Incident Reporting Information System (IRIS) or shall use the forms listed in section 15.4 of DRD 1268SA-002 or electronic equivalent to report mishaps and related information required to produce the safety metrics.

### **3.0 Technical Requirements**

#### **3.1 Engineering and Integration Support for Avionics System Integration and Simulation**

The Contractor shall provide specialized engineering and integration services including, but not limited to, system design, system integration, real-time software development, and engineering modeling, software development, and expertise in supporting the integration of models and simulations in a distributed computing environment. This shall include, but not limited to, the design, development, test, and integration of A Real-Time Environment for Modeling, Integration, & Simulation (ARTEMIS).

- **System Integration and Engineering Support**

The Contractor shall support the MSFC effort in defining functional capabilities and associated development planning activities of system integration and simulation assets. The Contractor shall provide guidance on the projected development and integration of these functional capabilities, the need dates, and the associated development plans. The Contractor shall assess system integration and simulation capabilities and plans in conjunction with the project offices and other Engineering Directorate organizations. The Contractor shall participate in coordination meetings with identified stakeholders and other members of the development team; identify, coordinate, and participate in key trade studies to feed key decision-making regarding the development of the system integration and simulation capabilities and implementation plans. The Contractor shall participate in the coordination, communication and documentation of any materials, databases, schedules or other data packages as required.

The Contractor shall provide expertise in the development of the real-time software for execution within the system integration and simulation capability and their component modeling and simulation assets. This expertise shall include, but not limited to, the design, development, implementation, test, verification, validation, accreditation, and maintenance of the simulation systems, the simulations executed on these systems, and the algorithms and models contained within the simulations. The necessary tasks consist of support with requirements formulation; requirements analysis; lab design; mathematical model development of systems, subsystems, and algorithms; integration of the mathematical models into simulations (non real-time and real-time); verification and validation of mathematical models and simulations; real-time performance evaluation of simulations; development of test plans and

procedures; conducting tests; and improving and maintaining existing software models and simulations. The Contractor shall adapt existing software applications middleware for system integration and simulation applications.

The Contractor shall provide expertise in support of modeling and simulation management activities. The Contractor shall support the implementation of the modeling and simulation management activities, modeling and simulation resources and asset management, modeling and simulation verification, validation, and accreditation activities.

- **Geographically Distributed Simulation Design and Development**

The Contractor shall provide engineering modeling and software development to support geographically distributed simulations by providing modeling and simulation expertise to upgrade and maintain the ARTEMIS software to incorporate new interfaces and functionality as required.

### **3.2 Flight & Ground Software Support**

The Contractor shall support the development of flight and ground software for NASA/MSFC projects. This support shall include, but not be limited to, the formulation and coordination of software requirements, software design, software development, software integration, and software testing. This task requires participation in various project reviews including progress reviews, requirements reviews, avionics reviews and various Technical Interchange Meetings (TIMs) and lifecycle design reviews such as but not limited to Preliminary Design Review (PDR) and Critical Design Review (CDR).

### **3.3 Flight Robotics Lab (FRL) and Contact Dynamics Simulation Lab (CDSL) Support**

The Contractor shall support the development, evaluation, and testing of government and commercial Automated Rendezvous and Capture (AR&C) components and systems. This support shall include, but not limited to, work in support of the FRL and CDSL facilities through the development of test plans, procedures, component math models, pre-test predictions, hardware-software integration and check out, data collection, reduction, analysis, and test conduct.

### **3.4 Vehicle Dynamics Model Development for GNC Support**

Support vehicle dynamics model development for Guidance, Navigation, and Control (GNC) flight readiness certification capability. An examination of a launch vehicle dynamic environment, including dynamics associated with actuator, flexible body, slosh dynamics, and nozzle dynamics, will be performed. A key task objective is the recommendation for GNC simulation/ analysis tool capability with respect to dynamic model formulation and dynamic model fidelity. Single body vs. multi-body

formulation, nonlinear dynamics inclusion, simulation execution time, and applicability to a particular launch vehicle configuration are to be included in trade considerations. The examination will be performed in off-line tools utilizing a Boltzmann-Hamel formulation (or similar formulation), and task products will include status reports/presentations and the dynamic equations of motion with detail derivation as required.

### **3.5 Flight Robotics Lab (FRL) Dynamic Overhead Target Simulator (DOTS) Computer Interface Hardware Replacement**

The Contractor shall replace the obsolete Computer interface hardware (including VME interface boards and a SGI Origins computer) with standalone motion controllers (such as Galil's DMC 4040 Servo controllers) that can interface directly with the AB1388 Servo Amplifiers and Stegmann joint encoders of the Dynamic Overhead Target Simulator (DOTS).

The Contractor shall assess, select, purchase and support installation of standalone motion controllers (such as Galil's DMC 4040 Servo controllers) that can interface directly with the AB1388 Servo Amplifiers and Stegmann joint encoders of the Dynamic Overhead Target Simulator (DOTS) and provide control and feedback to the DOTS Control computer via high-speed interface such as Ethernet and provide manual control via a Jog Panel similar to the existing panel.

Program the standalone servo motion controller(s) to control the DOTS joints including joint command processing, joint safety, and joint control ramping currently performed by DOTS hardware and software.

Implement the 6DOF relative position to DOTS joint commands and/or Tilt Table Pitch & Yaw commands incorporating joint limits, safety limits & zones, and other required functions implemented in the existing DOTS control software and Desktop DOTS simulator. This new DOTS controller shall run on one of the newer FRL simulation computers.

The performance of the DOTS with the Tilt Table will be verified and characterized performing simple manual control and simple script command files and running a simple relative motion math model.

## **4.0 Travel**

The contractor shall travel as requested to accomplish each technical requirement. Travel estimates for the period of performance as listed below. Travel projections are assumed to be one (1) person and five (5) days per trip. The government will authorize this travel as required during the period of performance.

- Eighteen (18) trips to NASA JSC in Houston, TX per contract year.
- Ten (10) trips to NASA KSC in Cocoa Beach, FL per contract year.

The number of trips, travel locations, number of people and length of stay can change based on the customer's requirements. These are engineering estimates for quote purposes.

## **5.0 Materials**

The Contractor shall only purchase materials that will be used to accomplish the effort assigned to them. Any materials being purchased must be approved by the Contracting Officer's Technical Representative or Technical Monitor and the Contracting Officer prior to purchase.

## **6.0 RESERVED**

## **7.0 Personnel Skill Levels**

The Contractor shall provide skills at a level to perform the sub elements in this order.

## **8.0 Technical Milestones and Deliverables**

The Contractor shall provide copies of the Monthly Progress Report to the COTR and Contracting Office.