Marshall Space Flight Center
Engineering, Science & Technical Services

JACOBS
ESTS Group

Task Order Plan (TOP)

Contract Number: *NNM05AB50C*
TO Title: *Constellation Support to Spacecraft and Vehicle Systems*
TO Number: *32-000002* **Revision:** *01*

Period of Performance: *10/02/2010* to *09/30/2011*

MSFC Initiator: *Alicia Carroll (Task Initiator)*

(b)(4)

Emergency: *No*

Revision 1:
The purpose of this revision is to capture the changes resulting from customer direction based on the Program of Record (POR) allocation. The Task Order Description, Schedule, Performance Plan and estimate have been updated to implement these changes. The Specific updates are described below:

- Subelement AG: Created at the request of the EV customer to capture the effort started in 32-090407-AA. The subelement estimate is (b)(4)
- Subelement CA: Revised the mix of support to provide for the POR required CEQATR tailoring, resulting in a subcontractor estimate reduction of (b)(4) and a labor estimate increase of (b)(4)
- Subelement CB: Revised to reduce the scope and delete Special Tools Required as requested by the customer.
- Subelement CD: Revised to close the subelement at the direction of the customer, resulting in a subelement estimate decrease of (b)(4)
- Subelement CG: Revised the mix of support to provide for the POR required scope of insight/oversight for structural design and system interfaces, resulting in an increase in the labor estimate of (b)(4)
- Subelement CJ: Revised the mix of support to provide for the POR required scope of engineering modeling and mockups, resulting in a labor estimate increase of (b)(4) Added a Material estimate of (b)(4) to purchase material for the mockups as requested by the customer. Added Other estimate of (b)(4) for personal protection equipment needed for the task.
- Subelement CN: Revised the mix of support to provide for the POR required scope of discipline integrators for loads, natural environments and structures, resulting in a decrease in the labor estimate of (b)(4)
- Subelement CS: Revised to reduce scope for aeroacoustics and venting support and increase scope for attendance and presentation of papers at the JANNAF conference at the direction of the customer. These scope changes result in a decrease in the labor estimate of (b)(4) a decrease of the Subcontract estimate of (b)(4) and an increase in the Other estimate of (b)(4)
- Subelement CV: Revised to broaden the scope to adequately provide the support requested by the customer.
- Subelement CW: Revised the mix of support to provide for the POR required scope of cross-discipline integration of system verifications, resulting in a labor estimate decrease of (b)(4)

- Subelement CX: Revised the mix of support to provide for the POR required scope for physics based modeling support, resulting in a labor decrease of (b)(4) and a subcontract increase of (b)(4)
- Subelement CZ: Increased the scope to add knowledge capture facilitation requested by the customer, resulting in a labor increase of (b)(4) and a subcontractor estimate of (b)(4) Corrected the schedule to reflect the estimated period for this subelement.
- Subelement DB: Created at the request of the EV customer to capture the effort started in 32-090407-CA. The subelement estimate is (b)(4)
- Subelement YA: Renamed Subelement CE to Subelement YA in order to correctly identify it as support to the Constellation Level 2 office. Increased the subcontractor estimate by (b)(4) due to a rate increase resulting from the POR direction.

Revision 0: (Revision 1 update)
The Jacobs ESTS Group will provide support to the Spacecraft and Vehicle Systems Directorate on the Constellation program under the subelement mapping shown below:

32-000002 Sub-element	Previous Task Order-Subelement	Subelement Title
AA	32-030222-AA	Ares V Core Stage
AB	32-030222-AB	Ares V Vehicle Integration
AC	32-030222-AC	Ares V 1st Stage
AD	32-030301-AA	Aerosciences Support for Ares V Vehicle Integration
AE	32-090101-AA, 32-090101-AB	Ares V Requirements Definition
AF	32-090201-AA	Ares V Vehicle Integration Support
AG	32-090407-AA	Ares V Knowledge Management Support
CA	32-000001-CA	Integrated Test and Evaluation Support
CB	32-000001-CB	FS Structural Stress Support
CC	32-000001-CC	FS Structural Design Support
CD	32-000001-CD	FS Aeroscience Support
CF	32-000001-CF	Booster Re-entry Analysis
CG	32-000001-CG	First Stage System Engineering & Integration Support
CJ	32-000001-CJ	Analysis and Concept Develop-ment Support
CL	32-000001-CL	US Structural Stress Support
CM	32-000001-CM	US Structural Design Support
CN	32-000001-CN	Upper Stage System Design Sup-port
CP	32-000001-CP	VI Structural Dynamics and Loads Support
CR	32-000001-CR	Vehicle Structural Design Integra-tion
CS	32-000001-CS	VI Aeroscience Support
CT	32-000001-CT	GN&C Flight Control Design & Analysis
CU	32-000001-CU	GN&C and Navigation Design, Analysis and Modeling
CV	32-000001-CV	Health Management Design & Analysis
CW	32-000001-CW	Vehicle Systems Design Integra-

		tion
CX	32-000001-CX	VI Design Analysis and Integration
CY	32-000001-CY	Vehicle Development and Flight Evaluation
CZ		Knowledge Management Support
DA		1st Stage Structural Dynamics and Loads Support
DB	32-090407-CA	Integrated Engineering Process Planning
EA	32-090404-EA	LAS Risk Management
YA	32-000001-CE	Space and Terrestrial Environ-ments Support

1.0 Task Order Description & Objectives

Subelement AA-Ares V Core Stage

Objectives include participation in technical meetings, providing input to planned mass trade studies, and generating preliminary design, weight and layout inputs to involved managers and individuals as requested to support scheduled team outputs and material for major milestones. Create and maintain reference design information for the ARES V core stage. Provide design insight for trade studies related to each element of the ARES V core stage. Serve as Integrated Model point of contact to the SE&I group. Provide CAD-generated mass properties to the SE&I group. Coordinate interface requirements with other ARES IPTs. Coordinate inputs with other IPTs to ensure operability, accessibility, etc.

Stress analysis will be performed to include Hypersizing of structural components and tank sizing for trade studies.

Create engineering product developments to include core stage optimization, core stage test plans, development plans, and subassembly test plans.

Subelement AB-Ares V Vehicle Integration

Objectives include participation in technical meetings, providing input to planned mass trade studies, and generating preliminary design, weight and layout inputs to involved managers and individuals as requested to support scheduled team outputs and material for major milestones. Create and maintain reference design information for the ARES V core stage. Provide design insight for trade studies related to each element of the ARES V core stage. Serve as Integrated Model point of contact to the SE&I group. Provide CAD-generated mass properties to the SE&I group. Coordinate interface requirements with other ARES IPTs. Coordinate inputs with other IPTs to ensure operability, accessibility, etc.

Create engineering product developments to include vehicle trajectory, vehicle optimization, vehicle test plans, development plans, and assembly test plans.

Subelement AC-Ares V 1st Stage

Objectives include participation in technical meetings, providing input to planned mass trade studies, generating preliminary design including aft thrust support, weight and layout inputs to involved managers and individuals as requested to support scheduled team outputs and material for major milestones. Create and maintain reference design information for the ARES V 1st stage. Provide design insight for trade studies related to each element of the ARES V 1st stage. Provide CAD-generated mass properties to the SE&I group. Coordinate interface requirements with other ARES IPTs. Coordinate inputs with other IPTs to ensure operability, accessibility, etc.

Create engineering product developments to include 1st stage optimization, 1st stage test plans, development plans, and subassembly test plans.

Subelement AD- Aerosciences Support for Ares V Vehicle Integration

The objective of this subelement is to provide Aerosciences support for Ares V studies, trades, and preliminary design activities. These tasks require expert historical knowledge of launch vehicle aerodynamics, aerothermodynamics, plume environments, and aeroacoustics. These tasks require coordination of these disciplines into vehicle-level design studies, trades, and preliminary design assessments.

The following activities shall comprise these tasks and support:

a. Provide engineering method or empirical aerodynamic predictions and assessments.
b. Support wind tunnel testing, data reduction, and aerodynamic database preparation.
c. Provide aerothermodynamic and rocket exhaust plume heating analyses using engineering methods, CFD, and/or empirical relationships.
d. Provide aeroacoustic environment predictions using empirical methods.
e. Provide vehicle base heating assessments and predictions using empirical methods.
f. Coordinate and serve as the point of contact for the Aerosciences sub-disciplines (aerodynamics, aerothermodynamics, aero acoustics, base heating, and plume environments) in Ares V related preliminary design, trades, and assessment activities.

Subelement AE- Ares V Requirements Definition

The Jacobs ESTS Group shall support the MSFC Engineering Directorate by providing Systems Engineering for the Ares V vehicle including, but not limited to specialized Functional Flow-Block Diagramming, requirements development and traceability utilizing specialized System Engineering software packages such as CRADLE.

The Jacobs ESTS Group shall support tasks in support of the development, decomposition, and validation of system level requirements for Ares V:

- Ensure that the requirements and associated documentation, including the Ares V System Requirements Document (SRD) and the Requirements Validation Database are developed and maintained.
- Ensure requirements traceability from the Constellation Architecture Requirements Document (CARD system level requirements) to the elements.
- Ensure requirements validation to include vehicle requirements verification statements and subsequent detailed verification objectives (DVO) from the Constellation Architecture Requirements Document (CARD system level requirements) to the elements.
- Development of key design and integration products for project milestones (PDR, CDR, etc).

Support trade study process development necessary to ensure complete integrated vehicle design and development

Subelement AF-Ares V Vehicle Integration Support

Personnel will provide vehicle technical integration support, for Ares V, including the development and maintenance of integrated design analysis procedures, plans, and documentation. Identification and documentation of product content, development and coordination of products across vehicle engineering disciplines, book manager functions in support of technical reviews and approval boards, and support for technical and programmatic meetings and reviews will be provided.

Subelement AG-Ares V Knowledge Management Support (Revision 1 addition)

Provide System Engineering including knowledge management support to the EV94, Systems Planning Branch, Risk Management and Assessment Group and its customers. Provide direct support, expertise, and mentoring in the sound assessment and management of knowledge for Ares V and applications to other launch vehicles.

Subelement CA-Integrated Test and Evaluation Support

Office automation software will be utilized as appropriate to develop the post flight analysis plan. This software will include Microsoft Office products such as Word, Excel, Power Point and Project. The Jacobs-ESTS Group will develop the post flight analysis plan using available Ares I-X flight data parameters as the basis for analysis planning. Personnel will interact with multiple ED organizations, Ares I-X, various APO stage organizations and Flight and Integrated Test Office (FITO) staff to coordinate optimal analysis plans. A draft plan will be developed and delivered monthly for organizational and project review. Comments will be evaluated and incorporated when appropriate. The plan should include MSFC organizational analysis assignments and timing of when analyses will be performed after the flight.

The flight evaluation support will include preparation of evaluation documents for publication and coordination of flight evaluation presentations, meetings, and reviews.

The Jacobs-ESTS Group shall provide engineering and programmatic support in review and assessment of Ares I design documentation, CEQATR documentation, applicability to Ares I and V Multi-Unit Modules [MUM], integrated assemblies and major assemblies, tailoring of test plans per CEQATR specifications, requirement compliance and/or deviations, and coordination with relevant NASA design/control boards and panels. The Jacobs-ESTS Group shall develop a process which interprets the intent and guidelines of CEQATR and the implementation plan for Ares I. The process will be developed and delivered monthly for organizational and project review. Comments will be evaluated and incorporated when appropriate. Office automation software will be utilized as appropriate to develop the process. This software will include Microsoft Office products such as Word, Excel, Power Point and Project.

The Jacobs-ESTS Group shall provide systems engineering, programmatic support, and documentation development for Vehicle and Integrated Systems Test Support. Systems engineering tasks include generation and/or review of test requirements and procedures, analysis of test data, technical documentation review, participation at design and test readiness reviews, verification planning, and preparing summary charts of technical data. Programmatic support includes preparing, reviewing, and/or evaluation of planning documents such as project plans, test plans, reports, test procedures, risk management plans, organization charts, and schedules. Programmatic support also includes preparing summary charts, and presenting data and information. Documentation development includes writing and/or reviewing documentation and serving as a (b)(4) (b)(4) This also includes performing systems analysis/operations research and conducting special studies.

The Jacobs-ESTS Group shall provide systems engineering, programmatic support, and documentation development which can lead to the vibration test of the integrated Ares/Orion vehicle. This shall include a review of the test planning and requirements documentation, the preliminary design documentation of the ground support test and handling equipment, the data handling requirements and plans; the writing of "comments" as opposed to RIDs, the resolution of the comments and the updating of the documentation and the delivery of the documentation to the Ares CDR check point data package.

The Jacobs-ESTS Group shall provide IVGVT schedule review, coordination, and assessment. Support FITO to ED action item tracking, coordination, and status. Participate and response to various studies, trades, and options assessments. -Coordinate team meetings, Webex, telecons. Compile, review & distribute IVGVT weekly, monthly charts. Contribute to the review, development, and revision of IVGVT related documentation including (but not limited to) the Ares Integrated Test Plan (ITP), IVGVT Test Plan, IVGVT Test Implementation Plan, document tree, and requirements documents. Submit risks, risk mitigation plans, and status. Participate in working Thrust Oscillation (TO) issues related to IVGVT. Participate in meetings as required including, but not limited to, the following: Weekly Meetings, EV Tag-Up, IVGVT weekly meeting, Risk management meeting, US tag-up, ICD meeting, Documentation meeting, Bi-monthly Analysis Working Group meeting, Monthly GSE meeting, and Facilities meeting.

Subelement CB- FS Structural Stress Support (Revision 1 update)
This subelement provides structural engineering insight of the Ares I First Stage and in particular the Major Structures and Deceleration Subsystems to EV31. The major tasks include but are not limited to:

- Attending and supporting Engineering Meetings/Reviews and track issues related to structural strength, fracture mechanics and fatigue,
- Review/assess FS design and design changes and provide approval or disapproval recommendations.
- Documenting/presenting results.
- Perform independent strength and life analysis of select FS components.

Subelement CC-FS Structural Design Support
The Jacobs ESTS Group will provide engineering support for Ares I flight evaluation. The Flight Evaluation effort consists of the planning for launches of the Ares I launch vehicle followed by post flight evaluation of Ares I flight data. The task consists of the development of the CxP 72354 Ares I Flight Evaluation Plan. The task includes coordination with other Ares I WBS's, the Ares I Elements (first stage, upper stage and J2-X engine) and Orion in technical areas concerning Flight Evaluation. The effort will require close coordination with the Ares I Flight Integrated Test Operations (FITO) group to determine the configuration of the Development Flight Instrumentation (DFI) for Ares I.

Ares I Flight Evaluation Planning Document- This plan will provide organization, schedule, participants, and processes for implementing flight evaluation, for acquiring and distributing flight data, for reporting results of flight evaluation efforts, and for documenting flight evaluation results of Ares I flights

Provide structural design oversight responsibility for the Ares I First Stage vehicle element. Specific duties include the oversight of the structural integration of the thermal curtain, Booster Separation Motors, Booster Tumble Motors, Ballast, Cameras and integration of the System Tunnel.

Subelement CD- FS Aeroscience Support (Revision 1 deletion)
The objective of this subelement is to provide Aerosciences support for Ares I and Ares I-X First Stage Booster studies, trades, and design analyses cycles. Vehicle structures and Decelerator Sub-systems assessments will be made and incorporates a multi-disciplined approach which relies on historical knowledge of launch vehicle characteristics, empirical estimations, and evaluation of computational predictions.

Subelement CF- Booster Re-entry Analysis
Provide technical support to the Ares program for vehicle integration and booster re-entry analysis. This will involve the review of MSFC models that directly support Ares. These models would include the Vehicle and Solid Rocket Booster (SRB). Support teleconferences and meetings of the Ares panel in order to provide insight into current issues. Provide technical support, as required for unexpected integration issues. Provide Thrust Vector Control (TVC) related analyses, and participate in technical interchange meetings, design reviews, test readiness reviews.

Subelement CG- First Stage System Engineering & Integration Support
The Jacobs ESTS Group will provide system engineering support to the Stage Design and Integration Branch/EV81 in the Vehicle Stage Engineering and Integration Division, specifically for First Stage Systems Engineering & Integration activities. It will provide technical expertise and coordination support in all levels of EV81 and customers such as Ares I and Orion. Provide integration subject matter expertise in such areas as structures (includes loads, stress, design) and propulsion systems, both liquids and solids. Support requirements definition and documentation activities and the development of systems engineering management and analysis plans and processes. Facilitate the meetings and related tasks for the First Stage Integration Working Group (FSIWG). Support, develop, and communicate processes for First Stage requirements verification and Assess and coordinate

approval of derived verification plans. Support project and engineering documentation such as the Concepts of Operations, Design Reference Mission, and System Definition documents.

Subelement CJ- Analysis and Concept Development Support

The Jacobs ESTS Group will provide engineering analysis support to the Stage Analysis Branch/EV82 for multiple Upper Stage Elements and Engineering Organizations. The Jacobs ESTS Group will develop concepts, plans, analyses, technical reports, modeling and simulations, and technical presentations for projects. It will provide engineering visualization, modeling, and simulation support across multiple disciplines for system analyses and subsystem analyses.

The Jacobs ESTS Group will provide Human Factors Engineering support for design, development, test, and evaluation. Conduct analyses and perform trade studies supporting operations for human and human/robotic activities. Post Preliminary Design Review document updates will also be provided.

The Jacobs ESTS Group will provide Analysis, Modeling and Simulation support for Ares launch vehicles. Develop and maintain engineering products, reports, and/or databases used to define and integrate systems and subsystems including, but not limited to an integrated system schematic for Ares launch vehicles. Plan and conduct system analyses using models and simulations of integrated systems and subsystems.

The Jacobs ESTS Group will provide Mass Properties support to coordinate mass estimations from Integrated Product Teams (IPTs) and providing technical insight and appraisal of the conservatism used in their estimating process. Verify the mass and center of gravity requirements and propose changes to requirements as necessary.

The Jacobs ESTS Group will provide Engineering Modeling and Mock-up Support. Provide systems engineering, human engineering, operations engineering and safety support for the design, development, test, and evaluation of the Performance Analysis Design Demonstrators (PADDs). Develop and deliver the operations engineering documentation necessary for the development of the PADDs.

Subelement CL- US Structural Stress Support

The purpose of this subelement is to provide structural strength, stability, fracture, and fatigue analysis support for the Ares I Upper Stage. This subelement also includes the technical oversight of the Ares 1 Upper Stage Production Contractor.

Subelement CM- US Structural Design Support

Support the Stage Definition (SD) functions for the Crew Launch Vehicle (CLV) Upper Stage (US). This support will coordinate validation of US Computer Aided Design (CAD) models and assemblies, and will provide requirements integration and assessment among the various Upper Stage Integrated Product Teams (IPTs) and across CLV elements. Data input will be given to the MSFC Work Package Manager and other Task Leaders as required.

Provide engineering support to the Ares I Upper Stage (US) in the area of separation systems. Establish test and qualification plans for pyrotechnic components. Support testing and development of Ares I pyrotechnic components, review drawing/change packages as required.

Lead the design and Component Design Team (CDT) for the LO2 Tank. Provide engineering support to the other Core Stage CDT's, including Common Bulkhead, Thrust Cone, and LH2 Tank. Coordinate design inputs with other CDT's and disciplines to ensure operability, producibility, interfaces, accessibility, strength, functionality etc. Conduct layout reviews as required.

Provide Engineering Support for the Interstage design. Coordinate design inputs with other CDT's and disciplines to ensure operability, producibility, interfaces, accessibility, strength, functionality etc.

Conduct layout reviews as required. Provide mass properties inputs to the systems group. Assist in the development of interface definitions. Provide detail design of primary and secondary structure. Develop and deliver production drawings.

Subelement CN- Upper Stage System Design Support

The Jacobs ESTS Group will provide system engineering support to the Stage Design and Integration Branch/EV81 in the EV80/Vehicle Stage Engineering and Integration Division. It will provide technical expertise and coordination to EV81 supporting Ares I Upper Stage Systems Engineering and Stage Definition activities and products. Provide integration subject matter expertise in such areas as aerodynamics, structures (includes loads, stress, design), propulsion background in liquids & solids, systems integration, and interfaces. Support development of key analysis products for project milestones. Support trade study process development, management, execution, and other systems engineering products.

Subelement CP- VI Structural Dynamics and Loads Support

The purpose of this subelement is to provide vehicle integration (VI) structural dynamic analysis, loads, and modeling support to EV31 to support the Ares Project Office. Task work will include modeling, loads calculations, methodology and tool development, and other analyses to be performed as required to support EV31. Project tasks supported by this task order will include, but not limited to, coupled loads model and Load Transfer Matrix (LTM) generation and development, improved hydroelastic modeling and tool improvement, transient and frequency response analyses and assessments, loads and dynamic simulation analysis and development, vibroacoustics & shock environment derivation and development, insight analysis support, flight vehicle ground vibration test (GVT) and flight test analysis support including pre/post test analysis correlation, instrumentation selection analysis support and sensitivity assessments, and Thrust Oscillation (TO) analysis support, including modeling, methodology development, tool improvement, and dynamic simulations.

Subelement CR- Vehicle Structural Design Integration

Perform vehicle integration activities including managing and storing the information associated with the Ares 1 CAD OML, and ICD models using Pro-E and Windchill. This activity must be closely coordinated with First Stage, Upper Stage, Orion, Upper Stage Engine (USE), Ground Support Equipment (GSE),s etc. Develop and maintain these models using Pro/Engineer (Pro-E) and the Design and Data Management System (DDMS) Windchill Product Data Management System (PDM) system.

Additional support would include but not be limited to the following:

- Resolution of review item discrepancies (RID) related to task developed drawings.
- Roll up supplied OML interfaces from the various elements including details of all the major vehicle protuberances.
- Creation of ICD layout drawings to support production of ICD document views.

Specific Objectives:

- Facilitate creation and delivery of new business model practices from elements to vehicle integration by analyzing and providing feedback to elements and vendors.
- Coordinate with elements and book managers to insure methods to provide accurate updates to constellation level documents.
- Support Constellation PDR (March of 2010) efforts for vehicle integration.
- Develop models and drawings supporting the design of the following items:
  - Ares 1 Assembly
  - Integrated Vehicle Assembly
  - Integrated Vehicle Nominal Envelope Drawing
  - Integrated Vehicle Static Envelope Drawing
  - Integrated Vehicle Dynamic Envelope Drawing
  - Upper Stage to First Stage ICD Drawing
  - Review Upper Stage to Upper Stage Engine ICD Drawing

- Ares I to Orion ICD Drawing
- First Stage to Ground Systems ICD layout drawings
- Upper Stage to Ground Systems ICD layout drawings
- Integrated Vehicle Drawing Tree

- Create integrated stack OML models including staged flight OMLs.

Subelement CS- VI Aeroscience Support

The objectives of this subelement are to review aerodynamic products, perform wind tunnel tests, and provide expert empirical aerodynamic analyses and support ARES trade studies and evaluation of ARES wind tunnel, CFD, and engineering code predictions. This is inclusive of flight characteristics, static stability and control, dynamic damping, aerothermodynamics, venting, and aero-acoustics. Contributions will be made to the appropriate data books to update vehicle environments. Evaluation of data from the Ares I-X flight test vehicle will be made by comparisons to pre-test predictions and other available means with contributions being made to the Flight Evaluation Report. Codes and techniques will be updated in order to have consistent methodologies regarding follow-on studies.

Subelement CT- GN&C Flight Control Design & Analysis

Provide engineering support in the definition, development or derivation of system, subsystem or component requirements or specifications along with necessary analysis to demonstrate validity and feasibility of associated requirements or specifications. Assistance will be provided with development of Guidance, Navigation and Control (GN&C) subsystem requirements and requirements analysis. Requirement and specification definitions, derivation and analysis shall include but not be limited to servomechanism, control actuators systems and control system sensors.

Provide flight dynamics analysis; mathematical model development in high fidelity simulation; frequency domain stability analysis, including digital bending filter designs and stability margin and performance optimizations; quick turn-around trade studies that support design decisions.

Provide Pogo suppression design, test, and analysis; Support flight test vehicles, and future missions.

Subelement CU- GN&C and Navigation Design, Analysis and Modeling

Provide modeling data and document integration for GN&C high fidelity simulation. Support flight test vehicles, and future missions. Provide trajectory and performance analysis and perform trade studies for the Ares I program. Support will be provided for Ares I program teleconferences, meetings, and requirements reviews. Results of analysis and/or meetings/reviews will be documented. This will involve the review of MSFC models and reports that directly support Ares I.

Develop navigation process equations, error equations, and mathematic models used for navigation performance analysis and navigation system simulation. Develop and implement algorithms used for navigation performance analysis and navigation system simulation. Design and evaluate navigation system architectures. Interact with guidance and control engineers as well as other subsystem groups to furnish and request needed information and data. Provide GN&C Avionics Integration Support - requires meeting and interacting with GN&C engineers as well as other subsystem groups, panels, and vendors to gather and distribute information pertinent to the design and integration of a navigation system into the GN&C system.

Provide continued development of the Marshall Aerospace Vehicle Representation In C (MAVERIC) high-fidelity simulation program architecture for LINUX and/or UNIX operating systems to support the Flight Mechanics division Guidance, Navigation & Control (GN&C) algorithm design and performance analysis for launch vehicle development programs. The effort will include development of new vehicle subsystem or environment mathematical models for inclusion into MAVERIC on an as-needed basis to support the Ares 1 and Ares V GN&C design and performance analysis. Provide integration of all MAVERIC model, vehicle model and environment model revisions into the current "build" version of MAVERIC and prepare a debugged and working simulation for the next BETA version or MAJOR version release.

Subelement CV- Health Management Design & Analysis (Revision 1 update)
Integrate Abort, Caution and Warning (C&W) and Redundancy Management capabilities in support of the Flight Test program objectives for the First Stage, Upper Stage, Upper Stage Engine and Integrated Vehicle. Define and maintain logic for each abort trigger, C&W condition, and Redundancy Management function. Document information in the Fault Detection, Notification, and Response (FDNR) System Definition Document (SDD). Maintain the mapping of Failure Modes and Hazards to Abort Conditions and Abort Triggers. Update mappings with design maturation. Maintain cognizance of conditions initiated by 1, 2, or 3 failures for each system on the vehicle. Support analysis of abort, C&W, Redundancy Management (including the ability to fly through failures), and Diagnostic functions including diagnostic model development and maintenance. Provide concurrence that Testability; Engineering, Analysis, and Maintainability (TEAMS) models accurately represent the vehicle systems. Support failure propagation, failure mapping, and operability assessments using the TEAMS model. Support test activities with planning inputs and post-test data analysis. Support lessons learned and process improvement activities.

Subelement CW- Vehicle Systems Design Integration
Provide engineering support for the development, flowdown, and integration of vehicle requirements verification statements and subsequent detailed verification objectives (DVO). Ensure the successful integration of requirements and interfaces with the overall vehicle design to ensure the integrated design capability to meet the mission and project requirements set. Support the assurance of verification traceability from Level 2 program requirements down to the Level 4 element requirements. Support the integration of Level 3 activities associated with verification with the program, other projects, and the elements.

Provide specialized engineering leadership or support for the technical integration of hardware elements and/or specific engineering design disciplines. Hardware integration engineering may include fluid, mechanical, and/or electrical integration of flight hardware elements and systems. Discipline engineering integration may include one or more of the following: structures, loads, dynamics, thermal, propulsion, avionics, flight mechanics, GN&C, and operations. Personnel will function as specialists to ensure successful integration of hardware and/or engineering disciplines. Integration activities include all technical and administrative activities required to provide for and document the integrated interface design. Work involves the identification and coordination for the performance of detailed analyses/design needed from each discipline to ensure successful product development. Work includes the identification, planning, and execution of risk reduction activities to close gaps in the vehicle requirements. Work involves the coordination and integration with other external elements and projects as well as internal product teams and engineering disciplines and the assurance that consistent methodology is employed across design disciplines. Example projects for technical integration include Ares I vehicle stabilization & damping, options for vehicle roll control, and safety-related matters such as external camera placement and launch abort scenarios and systems.

Perform as responsible Systems Engineer (SE) for assigned system level requirements. Work with other technical stakeholders to manage assigned requirements, including the following:

- Develop/concur with requirement statement
- Generate/evaluate verification statements
- Assess linkage to other requirements documents up one and down one level
- Assess cost/schedule impact to requirement/verification changes
- Generate compliance data for input into the Design Requirements Compliance Matrix
- Coordinate technical issue resolution
- Champion risk identification/mitigation planning
- Lead generation of Detailed verification Objectives (DVO) data
- Gather/assess verification data
- Develop Verification Closure notices (VCN)

The Jacobs ESTS Group will provide engineering support for hardware development and integration planning necessary to assist in achieving the VIO goals and objectives. Responsibilities include overall

Ares stack integration of hardware and software of Ares elements, avionics, GN&C, and the interfaces with Orion, Ground Operations, and Mission Operations. To support horizontal and vertical system integration, the VDFE supports the Vehicle Integration Team (VIT) to provide system technical assessments and resolve interface issues of the Ares Vehicle, support all interim development products such as development plans, Interface Requirements Documents (IRDs), Interface Control Documents (ICDs), functional flow diagrams, operation analysis, flight evaluation planning, and verification/validation matrices.

Subelement CX- VI Design Analysis and Integration

Provide support to the Vehicle Systems Analysis Branch (EV92). Functions include but are not limited to the following:

- Provide project coordination activities in support of the EV92 Branch, WBS 5.2.4, Integrated Design Analysis Team (IDAT), and associated working groups and panels. Includes preparation of branch and WBS presentations and reports, general meeting preparation and conduct, creation and maintenance of distribution lists and meeting attendees, identification and tracking of actions, recording of meeting minutes, and maintenance of meetings products on Windchill.
- Lead the development and maintenance of the Ares Ascent Timeline.
- Provide modeling support for the CLV system that includes model development, model assessment and verification, evaluation of design criteria related to operational goals, input for development and maintenance of tools and databases, input for failure propagation logic model development and quantification, input for probabilistic risk assessment, perform probabilistic design analyses, process development, input for project analyses, and support for design reviews and trade studies. Personnel will interface with engineering, the project office, element offices, and outside organizations to communicate the results of the analyses performed.
- Provide systems analysis support, detailed system design definition, simulation and modeling support, and document compilation and maintenance support for the Ares I integrated Vehicle Systems Management Team (VSM). Personnel will perform analysis of vehicle subsystems and define system interactions and dependencies necessary to carry out the mission objectives. This includes definition of vehicle states and allocation of subsystem functionality per vehicle state. Analysis must be performed and system definition must comply with all vehicle state definitions. Personnel will perform modeling and simulation design and development to represent vehicle operations and perform VSM algorithm verification based on this representation. Personnel will assist with document compilation and maintenance to support scheduled releases and updates to CxP 72290 – Vehicle Systems Management (VSM) System Definition Document (SDD).

Subelement CY- Vehicle Development and Flight Evaluation

The Jacobs ESTS Group will provide engineering support for hardware development and integration planning necessary to assist in achieving the VIO goals and objectives. Responsibilities include overall Ares stack integration of hardware and software of Ares elements, avionics, GN&C, and the interfaces with Orion, Ground Operations, and Mission Operations. To support horizontal and vertical system integration, the VDFE supports the Vehicle Integration Team (VIT) to provide system technical assessments and resolve interface issues of the Ares Vehicle, support all interim development products such as development plans, Interface Requirements Documents (IRDs), Interface Control Documents (ICDs), functional flow diagrams, operation analysis, flight evaluation planning, and verification/validation matrices.

The Jacobs ESTS Group will provide engineering support for the development and management of the following documentation:

- Definition of Standard Coordinate Systems for the Ares I Launch Vehicle- This Plan shall formulate a standard coordinate system program based on the Ares I/Orion integrated stack coordinate system definitions that can be effectively controlled and implemented early in the design and development phase to meet the Ares I/Orion Integrated Stack performance requirements. In addition, the standard is to provide nomenclature and coordinate systems for designers and analysts of Ares I/Orion Integrated Stack.

- Ares I Assembly Assessment Report-The Assembly Assessment Report describes the ability of the system to be assembled, and to do so within human factors considerations.
- Ares Assembly & Vehicle Integration Plan- To define the vehicle physical assembly and vehicle alignment.
- Ares I Development / Integration Plan- To document the development and integration activities necessary to demonstrate that each Ares Element meets its interface requirements and to document the integration of the Ares launch vehicle with FITO, Orion, Ground Systems, Mission Systems, and the Range in accordance with the Project IMS.
- Ares I Configuration Designations- This document is established for the purpose of delineating a uniform set of Ares Project, Element, and subsystem codes for use by all Ares project participants.

The Jacobs ESTS Group will provide engineering support for the development of integrated vehicle system schematics. Responsibilities include defining the overall schematic "architecture" and ensuring that all elements, systems, and subsystems are consistent, coordinating with the stages division for the development of the integrated schematic set, and providing for the integration of element schematics to show connectivity of power, data, fluid, mechanical, or other interfaces including Orion to Ares and GS to Ares.

The Jacobs ESTS Group will provide engineering support for the development and management of the following documentation: Integrated Launch Vehicle (ILV) System Schematics-To show energy path connectivity between LRUs within the Ares-I and Orion Elements, and between the Integrated Vehicle and the Ground Systems.

The Jacobs ESTS Group will provide engineering support for Ares I flight evaluation. The Flight Evaluation effort consists of the planning for launches of the Ares I launch vehicle followed by post flight evaluation of Ares I flight data. The task consists of the development of the CxP 72354 Ares I Flight Evaluation Plan. The task includes coordination with other Ares I WBS's, the Ares I Elements (first stage, upper stage and J2-X engine) and Orion in technical areas concerning Flight Evaluation. The effort will require close coordination with the Ares I Flight Integrated Test Operations (FITO) group to determine the configuration of the Development Flight Instrumentation (DFI) for Ares I.

Ares I Flight Evaluation Planning Document- This plan will provide organization, schedule, participants, and processes for implementing flight evaluation, for acquiring and distributing flight data, for reporting results of flight evaluation efforts, and for documenting flight evaluation results of Ares I flights.

Subelement CZ- Knowledge Management (KM) Support

This subelement, in direct support to EV94, Systems Planning Branch, will provide Knowledge Management support to the Risk Management and Assessment Group and its customers by providing direct support, expertise, and mentoring in the sound assessment and management of Knowledge for their programs, projects and customers.

Subelement DA-1st Stage Structural Dynamics and Loads Support

The purpose of this subelement is to provide First Stage structural dynamics and loads support to EV31 in support of the First Stage (FS) Systems Definition Group work package. Task work will include modeling, loads calculations, methodology and tool development, and other analyses to be performed as required to support EV31. Project tasks supported by this task order will include, but not limited to,

1) Keep EV31 informed of FS work and issues related to structural dynamics and loads.
2) Conduct structural dynamics modeling, analysis, loads calculations, dynamic simulations and other analyses, including modeling, model reduction, model integration, coupled loads model generation, Load Transfer Matrix (LTM) generation and development, improved hydroelastic modeling and tool improvement, transient and frequency response analyses and assessments, loads and dynamic simulation analysis and development, vibroacoustics & shock environment derivation and development, insight analysis support, ground vibration test (GVT) and flight test analysis support including pre/post test analysis correlation, in-

strumentation selection analysis support and sensitivity assessments and Thrust Oscillation (TO) analysis support for TO mitigation design and assessment and reference model assessment.

3) Review requirements.
4) Assess designs, design changes and analysis methodologies. Provide approval or disapproval recommendations.
5) Generate and review documentation.
6) Participate in FS technical meetings, reviews and boards for EV31.
7) Participate in the ARES I Loads and Structures Panel meetings in order to monitor integrated stack vehicle topics and discussions that affect the FS and relay FS concerns and issues to vehicle integration (VI).

Subelement DB- Integrated Engineering Process Planning (Revision 1 addition)
Provide system engineering support to the Systems Planning Branch/EV94 in the Spacecraft and Vehicle SE&I Division and its customers such as the Constellation project offices. Provide technical management advisory services regarding technical and management questions/issues/risks affecting the performance and outcome of EV94's work products and services. Provide advice, studies, assessments, independent analysis and/or recommendations for EV94 and its customers in such areas systems engineering processes, systems engineering, and management processes.

Subelement EA-LAS Risk Management
This Task Order, in direct support to EV94, Systems Engineering Planning and Control Branch, will provide technical risk support to the Risk Management and Risk Assessment Group of the Systems Management Branch Office in support to the Launch Abort System (LAS) project.

Subelement YA- Space and Terrestrial Environments Support (Revision 1 update)
The Jacobs ESTS Group will provide engineering support to the NASA/Environments Group (EV44) for the First Stage of the Ares I Project in a variety of space environments related discipline areas including:

- Ionizing radiation environment
- Ionosphere and plasma environment
- Neutral thermosphere environment
- Orbital debris environment
- Meteoroid environment
- Thermal environment
- External contamination environment
- General space physics including orbital mechanics, impact mechanics, charging effects analysis, space weather.

Activities in these discipline areas include data analysis and computer modeling to define the environment and its effects, requirements inputs, design review, design analysis, design support, testing support and operations support. In addition, staff will prepare space environments and effects training materials including presentations, example model runs, and other educational materials as well as participate in presentations to project personnel (both NASA and contractor) to help programs adequately address space environments issues in their design, development, and operations work.

2.0 Technical Approach (Including required input, guidelines & assumptions)

The Jacobs ESTS Group personnel will perform the work described above using standard office automation software including, but not limited to, Excel, PowerPoint, Word, Project, and Acrobat.

The Jacobs ESTS Group personnel will coordinate and interface with EV and project teams and personnel to accomplish the work described above. The Jacobs ESTS Group personnel will participate in reviews, meetings, Technical Interchange Meetings (TIMs), technical performance meetings,

teleconferences, working groups and in trade studies to complete the assigned tasks The Jacobs ESTS Group personnel will travel to NASA and contractor facilities, as required to support, reviews, meetings, TIMs, etc.

Subelement AA-Ares V Core Stage

The task will provide specific and general support for the ARES V project. The ARES V Integration Study is an intense effort that will assess potential vehicle configurations for the ARES V vehicle. As part of this effort determinations will be made concerning geometry and structural arrangements; thus, support is needed in those areas. More specifically, assistance is requested in the determination of vehicle mass fraction and how the calculation of mass fraction is performed. Additionally, support is needed to compare the derived mass fraction for ARES V with that mass fraction of previous launch vehicles.

Engineering development will provide oversight of analysis and structures sub-team for trade studies and alternate engine arrangements. A final report will be developed to include test plans.

It is assumed that the MSFC project office will schedule major design reviews.

Office automation software will be utilized as appropriate to carry out associated design documentation and calculations, structural analyses, and to create the required documentation for design reviews, engineering meetings and compilation of engineering data as required. This software will include but is not limited to MathCAD, Microsoft Office products such as work, Excel, Power Point and Microsoft Project.

Subelement AB-Ares V Vehicle Integration

The task will provide specific and general support for the ARES V project. The ARES V Integration Study is an intense effort that will assess potential vehicle configurations for the ARES V vehicle. As part of this effort determinations will be made concerning geometry and structural arrangements; thus, support is needed in those areas. More specifically, assistance is requested in the determination of vehicle mass fraction and how the calculation of mass fraction is performed. Additionally, support is needed to compare the derived mass fraction for ARES V with that mass fraction of previous launch vehicles.

Engineering development will provide oversight of analysis and structures sub-team for trade studies and alternate engine arrangements. A final report will be developed to include test plans.

It is assumed that the MSFC project office will schedule major design reviews.

Office automation software will be utilized as appropriate to carry out associated design documentation and calculations, structural analyses, and to create the required documentation for design reviews, engineering meetings and compilation of engineering data as required. This software will include but is not limited to MathCAD, Microsoft Office products such as work, Excel, Power Point and Microsoft Project.

Subelement AC-Ares V 1st Stage

The task will provide specific and general support for the ARES V project. The ARES V Integration Study is an intense effort that will assess potential vehicle configurations for the ARES V vehicle. As part of this effort determinations will be made concerning geometry and structural arrangements; thus, support is needed in those areas. More specifically, assistance is requested in the determination of vehicle mass fraction and how the calculation of mass fraction is performed. Additionally, support is needed to compare the derived mass fraction for ARES V with that mass fraction of previous launch vehicles.

Engineering development will provide oversight of analysis and structures sub-team for trade studies and alternate engine arrangements. A final report will be developed to include test plans.

It is assumed that the MSFC project office will schedule major design reviews.

Office automation software will be utilized as appropriate to carry out associated design documentation and calculations, structural analyses, and to create the required documentation for design reviews, engineering meetings and compilation of engineering data as required. This software will include but is not limited to MathCAD, Microsoft Office products such as work, Excel, Power Point and Microsoft Project.

Subelement AD- Aerosciences Support for Ares V Vehicle Integration

The technical analyses and evaluation associated with this subelement include empirical environment estimation, engineering level code utilization, and incorporation of engineering, CFD, and wind tunnel data in the development of Ares V preliminary design environments, characteristics, and associated products. This subelement further requires understanding and utilization of historical launch vehicle aerosciences data to anchor and further verify current predictions and associated analytical methods. This subelement also requires coordination of various aerosciences assessments, environments, and characteristics provided by other personnel into dedicated Ares V trade studies, assessments, and preliminary design activities.

Subelement AE- Ares V Requirements Definition

Task personnel will work as part of a larger customer/contractor team to provide leadership and coordination for the review of the product deliverable(s), internal and external, for the vehicle reviews or checkpoints. Integrate with elements and discipline engineers to document, disposition, negotiate, and close all discrepancies identified during major milestone reviews or other document drops.

Support will be provided for status and reporting of product deliverable(s) to the Ares V product team leadership. This includes the identification of issues, generation of issue/risk burn down plans, development of task schedules, and identification and communication of resource requirements. Task personnel will integrate with other product teams and/or design disciplines for the development of integrated task lists or schedules and the development of agreements (inputs/outputs matrices or other) to ensure the delivery of the integrated product.

Subelement AF-Ares V Vehicle Integration Support

The Jacobs-ESTS Group will assist in producing and managing system engineering and analysis products that support the Vehicle System Analysis and Attributes Branch and its customers. These efforts include the following general activities for each of the subelement areas defined:

(1) Work as part of a larger customer/contractor team to determine and negotiate between major elements and systems to arrive at proper plans, procedures and checkout requirements for the integration and assembly of assigned areas.
(2) Perform analyses and tasks to plan and document the necessary steps to assemble, integrate, and test equipment.
(3) Perform system engineering and analysis integration tasks. Create proper documentation and records to support activities.

Perform integration function with provided organization contacts to coordinate and obtain the necessary information to produce documents that meet program and customer requirements. Assist in the negotiation and approvals of technical issues and documents.

Subelement AG-Ares V Knowledge Management Support (Revision 1 addition)

The Jacobs-ESTS Group will perform the collection, interpretation, and preparation of information for presentation to internal and external customers to meet program/project goals. Jacobs-ESTS Group personnel will also provide systems engineering support associated with the development and evaluation of Knowledge management processes and documentation and other system engineering functions.

Jacobs-ESTS Group personnel will work independently and collectively with the EV94 organization and Ares V to organize knowledge management activities, create, collect, interpret, archive and disseminate knowledge related data. Personnel will perform analysis of data and report periodically for each assigned customer. Other typical tasks planned to be performed are as follows:

- develop knowledge assessment/management processes, plans and other analyses.
- support and participate in program/project product review meetings.
- support and provide knowledge related information for trade studies, trade tree development, and the decision making processes.
- prepare and track knowledge traceability.
- mentor team members in knowledge management, and use of tools and databases.
- facilitate Knowledge Manager activities including: Communicating KM processes, practices, status, and current/archived information via the KM web site. Provide appropriate knowledge management documentation to the LaSSe administrator for storage in that eLibrary. Provide facilitation support for knowledge capture events. Identify candidate Knowledge Objects for knowledge capture and transfer. Facilitate Case Studies for training purposes and knowledge transfer.

Subelement CA-Integrated Test and Evaluation Support

Task personnel will develop and review the development post flight analysis plan which will use available Ares I-X flight data parameters as the basis for analysis planning. Personnel will interact with multiple ED organizations, Ares I-X, various APO stage organizations and Flight and Integrated Test Office (FITO) staff to coordinate optimal analysis plans. The plan will be delivered monthly for organizational and project review. Comments will be evaluated and incorporated when appropriate. The plan should include MSFC organizational analysis assignments and timing of when analyses will be performed after the flight. The flight evaluation support will include preparation of evaluation documents for publication and coordination of flight evaluation presentations, meetings, and reviews. Task personnel will utilize Office automation software as appropriate.

Task personnel will review and provide assessment of Ares I design documentation, CEQATR documentation, applicability to Ares I and V Multi-Unit Modules [MUM], integrated assemblies and major assemblies, tailoring of test plans per CEQATR specifications, requirement compliance and/or deviations, and coordinate with relevant NASA design/control boards and panels. This shall include development and delivery of a process which interprets the intent and guidelines of CEQATR and the implementation plan for Ares I for monthly organizational and project review. Comments will be evaluated and incorporated when appropriate. Office automation software will be utilized as appropriate to develop the process.

Task personnel will perform systems engineering tasks include generation and/or review of test requirements and procedures, analysis of test data, technical documentation review, participation at design and test readiness reviews, verification planning, and preparing summary charts of technical data. Programmatic support includes preparing, reviewing, and/or evaluation of planning documents such as project plans, test plans, reports, test procedures, risk management plans, organization charts, and schedules. Programmatic support also includes preparing summary charts, and presenting data and information. Documentation development includes writing and/or reviewing documentation and serving as a (b)(4) [redacted] This also includes performing systems analysis/operations research and conducting special studies. Task personnel will work as part of a larger customer/contractor team to provide leadership and coordination for the review of the product deliverables, internal and external for the vehicle CDR (or other checkpoint). Integrate with elements and discipline engineers to document, disposition, negotiate, and close all discrepancies identified during major milestone reviews or other document drops.

Subelement CB- FS Structural Stress Support

Participate in technical meetings and discussions. Review proposed design changes and other technical data pertaining to strength, fracture and fatigue and perform independent analyses using finite element or classical techniques. Present findings and recommendations in the form of technical reports and formal presentations. Thoroughly review all results from assigned tasks to verify outputs

are complete, correct, integrated with project objectives, and adequately documented. Follow existing processes and procedures and recommend process improvements where appropriate. Participate in Process Improvement Teams and standing committees.

Subelement CC-FS Structural Design Support

Office automation software will be utilized as appropriate to carry out associated design documentation and calculations, thermal analyses, and to create the required documentation for design reviews, engineering meetings and compilation of engineering data as required. This software will include but is not limited to MathCad, Microsoft Office products such as work, Excel, Power Point and Microsoft Project. It is assumed that the MSFC project office will schedule major design reviews. Sketches, drawings and/or three dimensional (3D) models of design concepts will be generated using ProEngineer CAD software system using the Top-Down method developed by MSFC VIPA and in accordance with applicable MSFC quality procedure EV32-OWI-001 (Structural Design).

A Product Data Management (PDM) software system will be used to facilitate data transfer between the design and the subsystems. It is assumed that MSFC will provide the appropriate training to operate and maintain the database in the PDM system. This data may include CAD models, drawings, documentation, and design interfaces provided by the subsystems. Three-dimensional (3D) solid models and/or two-dimensional (2D) layouts of all hardware designs will be modeled using 3D-CAD software and a parametric, top-down design approach. These models will be integrated into the vehicle assembly being developed and stored in the PDM database. Detail part and assembly drawings may be produced from these models for hardware fabrication. This TO assumes that MSFC will have design control and that all releasable drawings Will be released through the MSFC release system. Products produced by this TO that are not required to be in the PDM system will be developed in accordance with the Mechanical Design Services and/or the Review Process as described in ESTS Performance Management System work instruction, W7202.1B and W720.1A respectively. Provide engineering development support to the Spacecraft and Vehicle Systems Department of MSFC. The main effort required under this subelement includes providing engineering support developing and or modifying the first stage Solid Rocket Booster (SRB) system currently baselined. Required inputs to establishing requirements will be developed in conjunction with MSFC and other members of the project team. Team input for test fixture requirements, test/qualification requirements and system requirements provided by other team members shall be provided in a timely manner in order to meet required deliverable.

Subelement CD- FS Aeroscience Support (Revision 1 deletion)

The technical analyses and evaluation associated with this subelement include empirical environment estimation, engineering level code utilization, and incorporation of engineering, CFD, and wind tunnel data in the development of the Ares I and Ares I-X First Stage booster design environments, characteristics, and associated products. This subelement further requires understanding and utilization of historical launch vehicle Aerosciences data to anchor and further verify current predictions and associated analytical methods. This subelement also requires coordination of various Aerosciences assessments, environments and characteristics provided by other branch personnel into dedicated First Stage trade studies, assessments, and design activities.

Subelement CF- Booster Re-entry Analysis

Participate in requirement reviews at the program, system, component, and test levels. Perform or review selected concept system and assembly architectural definition studies. Support design and implementation activities. Participate or observe, and report on development tests to evaluate upgrade designs. Perform analyses and research to resolve design issues. Review final trade study reports. Support closure of actions and issues pertaining to the selected design. Generate reports with recommendations to MSFC Task Initiator documenting efforts. Perform assessments of analysis models, detail designs, interfaces, software, manufacturing and fabrication/assembly processes, test plans and equipment, and test data.

Subelement CG- First Stage System Engineering & Integration Support

The Jacobs ESTS Group will support EV81 on FS SE&I by performing the following:

- Integrate information necessary to produce a validated/verified system at the level appropriate for each phase of development in support of all areas of SE&I within the First Stage Project Office.
- Define each information item(s) scope, format, and developer. Information items include parts lists, drawing trees, electronics drawings & schematics, specifications (requirements, manufacturing, logistics, assembly & check-out, operations), and validation of data analyses (including functional flow block diagrams & trade study results).
- Prepare and present traceability and rationale of applicable document to First Stage specifications.
- Negotiate requirement language with stakeholders and other team members.
- Lead system engineering efforts for verification, including support the development of sound validation and verification methods and proper documentation to support those methods.
- Provide input and assistance in the development and review of system and element requirements through the review and comment to First Stage specifications.
- Lead systems engineering efforts for First Stage to Ground Systems and First Stage to Upper Stage interface products, including review and coordination of structural, electrical, data, and environmental needs and products.
- Coordinate, update, and maintain First Stage interface documentation (i.e. ICDs, PIRNs, Bilateral Usage Agreement).
- Provide support and assessment of First Stage assembly and operations development.
- Review structures products and processes for accuracy and compatibility.
- Review stage assembly products and processes for integrated, and interface, requirement compliance.
- Participate in trade studies, as required.
- Provide technical coordination for the First Stage Design Analysis Cycle inputs from Vehicle Integration.
- Provide technical coordination for the review, approval, control, and delivery of First Stage Design Analysis Cycle outputs.
- Define First Stage critical math model criteria.
- Support and assess First Stage aborts products/integration.
- Assess the Flight Termination System for design compatibility and range safety compliance.
- Provide technical coordination for First Stage products reviews and approvals.
- Represent First Stage at Ascent Flight Systems Integration Group (AFSIG) meetings and coordinate participation.

Subelement CJ- Analysis and Concept Development Support

The Jacobs ESTS Group will support EV82 in Human Factors Engineering by performing the following:

- Develop Concept Models of Internal Access Ground Support Equipment using ProE
- Develop Limited Mock-up Concepts of Internal Access Ground Support Equipment using DELMIA.
- Provide Human Factors Engineering support for design, development, test, and evaluation.
- Develop virtual models/simulations of Ground Support Equipment and Upper Stage systems using DELMIA.
- Conduct analyses and perform trade studies supporting operations for human and human/robotic activities.
- Support modeling worksite analyses.
- Participate in human engineering fit checks, demonstrations, and tests. This includes developing, reviewing, and commenting on requirements and plans, participating in these activities, and evaluating the final documentation.

The Jacobs ESTS Group will support EV82 in Analysis, Modeling and Simulation by performing the following:

- Develop and maintain an Integrated System Schematic for Ares launch vehicles.

- Include all Upper Stage, Interstage, Upper Stage Engine, Ground System, Mission System, and RF interfaces in the Integrated System Schematics.
- Convert schematic and source data to single 'F' size drawing, or other size as appropriate.
- Depict source data at Line Replaceable Unit (LRU) level on drawings.
- Show appropriate level of detail sufficient to depict all energy path with symbology, as appropriate, to depict functions.
- Employ proper drawing practice including reference designators, drawing borders, terminators, between sheet designators, etc.
- Conduct system analyses using MATLAB to model Upper Stage integrated systems and subsystems.
- Develop and maintain engineering products, reports, and/or databases used to define and integrate systems and subsystems.
- Develop and maintain an integrated system schematic for Ares launch vehicles.

The Jacobs ESTS Group will support EV82 in Mass Properties by performing the following:

- Coordinate mass estimations from Integrated Product Teams (IPTs) providing technical insight and appraisal of the conservatism used in their estimating process.
- Generate monthly Technical Performance Metric (TPM) charts for US Project Team use as well as input into the integrated Ares mass properties.
- Generate quarterly US mass properties report in accordance with Data Requirements Description (DRD) SD 202, Ares I US Data Requirements List (DRL), Ares-USO-SE-25725. Mass properties report will include full dry mass properties (mass, center of gravity, moments of inertia, and products of inertia) for incorporation into Ares mass properties reports and other reports suitable for input into performance simulations.
- Participate in technical interchange and reviews between the other program's technical disciplines within the team (Critical Layout Reviews).
- Review US mass properties requirements and targets at US element and IPT levels.

The Jacobs ESTS Group will support EV82 in Engineering Modeling and Mock-up by performing the following:

- Develop and deliver the operations engineering documentation necessary for the development of the PADDs.
- Participate in human engineering fit checks, demonstrations, and tests. This includes developing, reviewing, and commenting on requirements and plans, participating in these activities, and evaluating the final documentation.
- Develop and construct physical models/mockups for use in design evaluation, analysis and review.
- Support analysis and trade study performance for contract end item operations.
- Support HFE fit checks, demonstrations and tests including accommodating special setups required to accomplish fit check, demonstration and test objectives.

Subelement CL- US Structural Stress Support

Perform strength, stability, fracture and fatigue analyses of Ares I Upper Stage Elements using finite element and classical methods. Analyses and assessments will be performed on behalf of EV31 to support trade studies and sensitivity studies for customer organizations such as Design, Guidance, Navigation and Control (GN&C), Thermal, and Test. Models shall be compatible with existing EV31 models and analyses shall be compatible with existing EV31 analysis codes as well as meet other requirements specified by EV31. This work will require loads and environments data from within EV31 and from external sources such as the Aerodynamics, Thermal Analysis, Propulsion, and various Vendors. Material data will be needed from the Materials and Processes (M&P) organization. Design and configuration data will be required from the relevant design organization.

Subelement CM- US Structural Design Support

It is assumed that the MSFC project office will schedule major design reviews.

Minor design reviews, engineering reviews/or meetings and required engineering technical activities to meet stage level reviews will be scheduled and coordinated by each CDT lead.

Sketches, drawings and/or three dimensional (3D) models of design concepts will be generated using ProEngineer CAD software system using the MSFC CAD standard and in accordance with applicable MSFC quality procedure EV32-OWI-001 (Structural Design) and EV32-OWI-002 (Research and Technology Design).

A Product Data Management (PDM) software system will be used to facilitate data transfer between the design team and the subsystems. It is assumed that MSFC will provide the appropriate training to operate and maintain the database in the PDM system. This data may include CAD models, drawings, documentation, and design interfaces provided by the subsystems. Three-dimensional (3D) solid models and/or two-dimensional (2D) layouts of all hardware designs will be modeled using 3D-CAD software and a parametric, top-down design approach. These models will be integrated into the vehicle assembly being developed and stored in the PDM database. Detail part and assembly drawings may be produced from these models for hardware fabrication. This TO assumes that MSFC will have design control and that all releasable drawings will be released through the MSFC release system.

Products produced by this TO that are not required to be in the PDM system will be developed in accordance with the Mechanical Design Services and/or the Review Process as described in ESTS Performance Management System work instruction, W7202.1B and W7200.1A, respectively.

Required inputs for these designs will be developed as a collaborative effort with other members of the IPT based on data supplied by the CLV program office and CLV integration office. The assumption is made that the requirements and design inputs being developed by other members of the project will be available in a timely manner.

Serve as the deputy lead of the S&T subsystem. Subsystem management products (schedules, manpower estimates, etc.) will be prepared according to project standards and provided to the S&T subsystem manager for approval. Conduct layout reviews and other meetings to ensure that the subsystem is meeting requirements and interfaces. Review and study ongoing work and make comments, provide technical inputs, and work special assignments as needed.

Create and maintain a CAD layout of the current configuration of the US structures. Provide configuration inputs to analysis teams as needed.

A CAD assembly will be created for the Upper Stage to check for structural interferences, to verify interfaces with other vehicle elements, and to provide mass inputs. Periodic reviews will also be used to verify that proposed element designs meet driving requirements and provide necessary interfaces with other elements.

Task personnel will review and study ongoing work and make comments, provide technical inputs and work special assignments as needed; utilize data and experience from previous launch vehicle systems to generate required inputs; and perform structural and system layouts to relay technical data.

Required inputs will be obtained from each of the US IPTs and component design engineers with the assumption that input from any of the above entities will be available in a timely manner.

Required inputs to establishing the separation and flight termination systems will be developed in conjunction with MSFC and other members of the project team. It is assumed that input for test fixture requirements, test/qualification requirements and system requirements provided by other team members will be provided in a timely manner in order to meet required deliverables. Inputs will be needed at least four months prior to any stage separation or flight termination development Test Requirements Review (TRR) which have yet to be scheduled. It is assumed that the test and analysis inputs being developed by other members of the project will be available at least four months prior to US CDR in order to support the data drop for that review.

Subelement CN- Upper Stage System Design Support

The Jacobs ESTS Group will support EV81 on US System Design by performing the following:

- Support integration activities between the volume integrators in System Design and the Vehicle Integration engineering and project offices.
- Represent Upper Stage System Engineering in technical performance meetings.
- Provide subject matter expertise in launch vehicle development, design analysis, trade studies, requirements development, risk mitigation, and technical assessments.
- Support US system interface definition and documentation by working with US subsystems, Ares I elements, and other projects such as ground systems and Orion.
- Support integration activities between the volume integrators, the discipline integrators, and the US subsystem engineering and project offices.

Subelement CP- VI Structural Dynamics and Loads Support

Methods, models, forcing functions, software tools, and analyses shall be compatible with existing EV31 models and analysis codes as well as meet other requirements specified by EV31. This task requires broad experience in integrated launch vehicle dynamics modeling and analysis, as well as familiarity with STS elements and MSFC requirements/procedures. This includes extensive experience with Ares I coupled loads models and Shuttle Level II models, experience in model generation, experience in model reduction and model coupling, experience with LTM generation, experience and knowledge of structural dynamic characterizations, knowledge of hydroelastic propellant modeling (i.e. HYDRO), knowledge of pressure stiffening, knowledge of fluid-structure coupling, knowledge of multidisciplinary loading events, knowledge of guidance and control sensor flexible-body requirements, knowledge of generating and running simulations, knowledge of Monte Carlo analyses, knowledge of high frequency vibroacoustic, acoustic and shock analysis methods and tools, knowledge of Statistical Energy Analysis (SEA) and Hybrid SEA vibroacoustic methods and tools, knowledge of classical vibroacoustic scaling methods, knowledge of formulating vibroacoustic, acoustic and shock criteria for design and test, knowledge of performing probability and confidence statistical analysis, knowledge of insight/oversight methods, knowledge of flight vehicle ground vibration test (GVT) and flight test analysis methods (pre-test analysis correlation, instrumentation selection analysis, sensitivity assessments, interfacing/coordinating with test representatives and test monitoring), knowledge of Thrust Oscillation (TO) analysis methods and tools (TO modeling, methodology development, tool improvement, and dynamic simulations, vibration absorbers, isolation systems and fluid-damper systems).

Subelement CR- Vehicle Structural Design Integration

Roll up OML exterior surface models from Elements to produce overall vehicle stack OML. Roll Up element level provided interface skeleton files and drawings for all interfaces related to vehicle design integration. Will investigate supplied interface models to ensure conformance with level II interface definition documents. Additional higher level interface skeleton models and drawings may be produced as for vehicle level design activity and in support of level II and III ICD documentation. Will use the interface and envelope models to produce design level drawings, configuration layouts, etc.

Utilize element provided light weight viewable to produce overall stack viewable. Use stack viewable to investigate design details at the vehicle level, produce detailed configuration layout, and to provide images to support other level II documentation.

Office automation software will be utilized as appropriate to create the associated process documentation and calculations. This software will include but not be limited to Microsoft Office (Word, Excel, and PowerPoint) and MathCAD.

Subelement CS- VI Aeroscience Support

The technical analyses and evaluation associated with this subelement include empirical aerodynamic estimation, modification of aerodynamics by use of superposition, and incorporation of engineering, CFD, and wind tunnel force and moment data in the development of corrected flight aerodynamic database products. Analytically, the approach will involve developing models, running the models, and

generating/evaluating the results utilizing Aerodynamic Preliminary Analysis System (APAS), Configuration Based Aerodynamics (CBAERO), Launch Vehicle Expert (LVX), Vehicle Acoustics Environments Program (VAEPP), Rocket Acoustic Prediction Tool (RAPT). This subelement also requires access to, and utilization of historical launch vehicle aerodynamic data to anchor and further verify current predictions and associated analytical methods.

Perform venting analysis using the Chamber-to-Chamber (CHCHVENT) computer code. Establish criteria for compartment purge flow rates and determine optimal vent sizes and locations. An assessment on the external influences of these vent locations will be made.

The technical analyses and evaluation associated with this subelement also includes empirical environment estimation, engineering level code utilization, and incorporation of engineering, CFD, Standard Plume Flowfield (SPF), Plume Impingement Program (PLIMP) and wind tunnel data in the development flight aerothermodynamic database products. This subelement also requires understanding and utilization of historical launch vehicle aerothermodynamic data to anchor and further verify current predictions and associated analytical methods.

The technical analyses and evaluation associated with this subelement further includes empirical aeroacoustic estimation, modification of aeroacoustic data by use of superposition, and incorporation of engineering, and wind tunnel fluctuating pressure data in the development of corrected flight aeroacoustic database products. Analytically, the approach will involve developing models, running the models, and generating/evaluating the results. The use of MATLAB/Simulink and other computer codes will be needed. Knowledge of FORTRAN and C programming languages to modify codes is necessary. This subelement also requires access to, and utilization of historical launch vehicle aeroacoustic data to anchor and further verify current predictions and associated analytical methods. All aspects of wind tunnel test planning, model fabrication, test conduct, data analyses, and reporting will be employed.

Subelement CT- GN&C Flight Control Design & Analysis

Perform requirement and specification definition and derivation as the project is developed. Requirements and specifications can include but are not limited to attitude and translation control system algorithms, momentum management schemes, data system rates and capacities, and control system telemetry needed for performance verification and health monitoring.
Perform a tracing of consistency of requirements and specifications from system level requirements through component specification. The analysis shall also include tracing of requirements and specifications through all validation and verifications tests to insure compliance is measured. Support, define and derive GN&C system error budgets consistent with all levels of project requirements. Provide documentation of all definition, derivation and analysis performed in support of the Spacecraft and Vehicle Systems Department requirements, specifications, and error budget developments.

Perform design and implementation of pitch/yaw autopilot enhancements for better stability and attitude tracking performance under large roll rates; stability analysis that includes roll coupling and that shows how high roll rates can be tolerated before pitch/yaw stability is lost; time domain analyses with enhanced pitch/yaw autopilot for First Stage and if necessary, Upper Stage as well. Perform Upper Stage autopilot design and stability analyses with smooth wall slosh model tank damping. Perform analysis of nonlinear slosh dynamics and formulation of equations for modeling; coding and testing of a nonlinear slosh model into a 6DOF vehicle simulation; and evaluation of control system performance with nonlinear slosh model in 6DOF simulations.

Provide independent pogo stability analyses of launch vehicles, as required. Provide a review with recommendations of the pogo stability models, as required. All models and data to be evaluated, analyzed, and reviewed shall be provided by MSFC. Pogo stability analysis tool shall be provided by MSFC. Participate in the validation activities for the pogo stability models. Participate in weekly review teleconferences on pogo suppressor design, development and qualification tests and provide recommendations for resolving issues identified in these coordination activities. Participate in weekly teleconference meetings of the Pogo Integration Working Group.

Subelement CU- GN&C and Navigation Design, Analysis and Modeling

Participate in requirement reviews at the program, system, component, and test levels. Support design and implementation activities. Perform analyses and research to resolve issues. Perform trajectory and performance analyses and trade studies using the Program to Optimize Simulated Trajectories (POST). Perform simulations to analyze flight mechanics issues including but not limited to dispersions, aborts, and derivation of design trajectories, using the Marshall Aerospace Vehicle Representation in C (MAVERIC) computer program. Support model development in POST and in MAVERIC in order to conduct the analysis. Generate reports with recommendations to MSFC Task Initiator documenting efforts.

- Participate in requirement reviews at the program, system, component, and test levels. Support design and implementation activities regarding Guidance, Navigation and Control (GN&C). Support closure of actions and issues pertaining to the selected design. Generate reports with recommendations to MSFC Task Initiator documenting efforts.
- Develop new vehicle subsystems or environment mathematical models for inclusion into the MAVERIC on an as-needed basis to support the Ares 1 and Ares V GN&C design and performance analysis. Integrate all MAVERIC, vehicle and environment model revisions into the current "build" version of MAVERIC. Prepare a debugged and working MAVERIC revision for the next BETA version or MAJOR version release. EV40 shall provide access to the MAVERIC high-fidelity simulation program. The development of the MAVERIC program shall be continued from previous development for a LINUX and/or UNIX operating System(s).
- Coordinate with the MAVERIC Configuration Management (CM) team and assist with configuration procedure design. Provide support to Flight Mechanics engineers which would include MAVERIC use instruction, program design and error resolution.

Subelement CV- Health Management Design & Analysis

Office automation software will be utilized as appropriate to carry out associated design documentation and calculations, and to create the required documentation for design reviews, engineering meetings and compilation of engineering data as required. This software will include but is not limited to Matlab, Simulink, Testability, Engineering Analysis and Maintainability System (TEAMS), and Microsoft Office products such as Word, Excel, Power Point and Microsoft Project.
It is assumed that the MSFC project office will schedule major design reviews.
Minor design reviews, engineering reviews/or meetings and required engineering technical activities to meet various reviews will be scheduled and coordinated.

Subelement CW- Vehicle Systems Design Integration

Task personnel will work as part of a larger customer/contractor team to provide leadership and coordination for the review of the product deliverable(s), internal and external, for the vehicle PDR (or other checkpoint). Integrate with elements and discipline engineers to document, disposition, negotiate, and close all discrepancies identified during major milestone reviews or other document drops.

Support will be provided for status and reporting of product deliverable(s) to the product team leadership. This includes the identification of issues, generation of issue/risk burn down plans, development of task schedules, and identification and communication of resource requirements. Task personnel will integrate with other product teams and/or design disciplines for the development of integrated task lists or schedules and the development of agreements (inputs/outputs matrices or other) to ensure the delivery of the integrated product.

Subelement CX- VI Design Analysis and Integration

The Jacobs-ESTS Group will assist in producing and managing system engineering and analysis products that support the Vehicle System Analysis Branch and its customers. The work will be performed using standard office automation software including Microsoft Project, Access, Excel, PowerPoint, and Word as well as the Enterprise Architect software tool for Unified Modeling Language (UML) modeling work and other software tools as needed to support VSM algorithm verification work. The products of this Task Order will be provided in formats defined by EV92 and its customers.

Project schedule inputs will be provided to the ESTS Group by EV92 and its customers. Eforts may include the following:

- Assisting in the generation of an assortment of engineering and project reports for internal and external dissemination;
- Developing schedules and activity reports; integration of operability design analysis activities
- Providing input for development of Probabilistic Design Analysis (PDA) plans
- Developing graphical representations of logic flows
- Preparing organizational performance reports
- Providing input for developing and maintaining the PDA models
- Developing input for PDA analyses to include failure propagation and quantification
- Reviewing engineering documents, data and drawings
- Participating in major milestone reviews
- Assisting the Book Manager of *CxP 72290 – Vehicle Systems Management (VSM) System Definition Document (SDD)* in the development, compilation and maintenance of this document
- Supporting formal design reviews
- Assisting in the generation of engineering and project status reviews and formal reviews
- Providing support to VSM model development in order to evaluate overall VSM design and associated algorithms
- Support the office management including meeting participation and coordination, support management briefings and development of presentations, project documentation; and support other related programmatic activities.
- Perform integration and coordination function for the branch as needed to develop products and conduct daily business.
- Perform system engineering and analysis integration tasks. Create proper documentation and records to support activities.

Interacting with multiple engineering disciplines and integrated product teams providing support for systems integration. Obtain the necessary information to produce documents that meet program and customer requirements. Assist in the negotiation and approvals of technical issues and documents.

Subelement CY- Vehicle Development and Flight Evaluation

Task personnel will work as part of a larger customer/contractor team to provide leadership and coordination for the review of the product deliverables, internal and external for the vehicle CDR (or other checkpoint). Integrate with elements and discipline engineers to document, disposition, negotiate, and close all discrepancies identified during major milestone reviews or other document drops.

Support will be provided for status and reporting of product deliverables to the product team leadership. This includes the identification of issues, generation of issue/risk burndown plans, development of task schedules, and identification and communication of resource requirements. Task personnel will integrate with other product teams and/ or design disciplines for the development of integrated task lists or schedules and the development of agreements (inputs/outputs matrices or other) to ensure the delivery of the integrated product.

Subelement CZ- Knowledge Management (KM) Support

This task support requires the collection, interpretation, and preparation of information for presentation to internal and external customers to meet program/project goals. This task also requires systems engineering support associated with the development and evaluation of Knowledge management processes and documentation and other system engineering functions.

Task personnel will work independently and collectively with the EV94 organization and its customers to organize knowledge management activities, create, collect, interpret, archive and disseminate knowledge related data. Personnel will perform analysis of data and report periodically for each assigned customer. Other typical tasks planned to be performed are as follows:

- develop knowledge assessment/management processes, plans and other analyses
- support and participate in program/project product review meetings

- support and provide knowledge related information for trade studies, trade tree development, and the decision making processes.
- prepare and track knowledge traceability.
- mentor team members in knowledge management, and use of tools and databases
- facilitate Knowledge Manager activities including: Communicating KM processes, practices, status, and current/archived information via the KM web site. Provide appropriate knowledge management documentation to the LaSSe administrator for storage in that eLibrary. Provide facilitation support for knowledge capture events. Identify candidate Knowledge Objects for knowledge capture and transfer. Facilitate Case Studies for training purposes and knowledge transfer.

Subelement DA-1st Stage Structural Dynamics and Loads Support

Methods, models, forcing functions, software tools, and analyses shall be compatible with existing EV31 models and analysis codes as well as meet other requirements specified by EV31. This task requires broad experience in vehicle dynamics modeling and analyses. This includes extensive experience with Ares I FS models, experience in model generation, experience in model reduction and model coupling, experience with LTM generation, experience and knowledge of structural dynamic characterizations, knowledge of hydroelastic propellant modeling (i.e. HYDRO), knowledge of pressure stiffening, knowledge of fluid-structure coupling, knowledge of multidisciplinary loading events, knowledge of guidance and control sensor flexible-body requirements, knowledge of generating and running simulations, knowledge of Monte Carlo analyses, knowledge of high frequency vibroacoustic, acoustic and shock analysis methods and tools, knowledge of Statistical Energy Analysis (SEA) and Hybrid SEA vibroacoustic methods and tools, knowledge of classical vibroacoustic scaling methods, knowledge of shock methods and tools, knowledge of formulating vibroacoustic, acoustic and shock criteria for design and test, knowledge of performing probability and confidence statistical analysis, knowledge of insight/oversight methods, knowledge of flight vehicle ground vibration test (GVT) and flight test analysis methods (pre-test analysis correlation, instrumentation selection analysis, sensitivity assessments, interfacing/coordinating with test representatives and test monitoring), knowledge of Thrust Oscillation (TO) analysis methods and tools (TO modeling, methodology development, tool improvement, and dynamic simulations, vibration absorbers, isolation systems and fluid-damper systems). Support definition of the First Stage structural dynamic requirements and models. Review program requirements to identify impacts on the First Stage design. Assess First Stage vehicle designs and models. Assess First Stage component designs and models. Generate system and/or subsystem models, perform hydrostatic analyses, perform pressure stiffening analyses, perform reductions, integrate models, perform model checks, perform modal analysis, generate LTMs, perform dynamics analysis and loads assessments, including frequency response and transient response analyses, and conduct sensitivity and trade studies. Perform vibroacoustic and shock analysis assessments for design and test.

Subelement DB- Integrated Engineering Process Planning (Revision 1 addition)

The Jacobs ESTS Group will provide direct support, expertise, and mentoring in the sound development, derivation, traceability, and management of System Engineering Products, Plans and Processes for their programs, projects and customers. Provide advice, studies, assessments, independent analysis and/or recommendations for EV94 and its customers in such areas systems engineering processes, systems engineering, and management processes. Functions include support to:

- Systems Engineering Management Plan (SEMP)
- Data Requirements List (DRL)
- Work Breakdown Structure (WBS)
- Technical Review Planning
- Generic instructions for projects

Subelement EA-LAS Risk Management

This task support requires the collection, interpretation, and preparation of information for presentation to internal and external customers to meet program/project goals. This task also requires systems engineering support associated with the development and evaluation of risk management processes and documentation and other system engineering functions.

Task personnel for will work independently and collectively with the EV94 organization and its customers to organize risk assessment activities, create, collect, and interpret risk related data. Personnel will perform analysis of risk data and report periodically for each assigned customer area. Other typical tasks planned to be performed are as follows:

- develop risk assessment/management processes, plans and other analyses
- support and participate in trade studies and trade tree development
- support and participate in program/project product review meetings
- prepare and present risk traceability and rationale
- support development of risk mitigation plans
- mentor team members in risk assessment utilizing Root Source Analyses, other methodologies and use of tools and databases
- support the management of risk databases
- facilitate risk statement development with stakeholders and other team members
- facilitate Risk Management Panel meetings and activities
- communicate Knowledge Management processes, practices, status, and current/archived information
- provide appropriate knowledge management documentation to the LaSSe administrator for storage in that eLibrary
- provide facilitation support for knowledge capture events
- identify candidate Knowledge Based Risks for knowledge capture and transfer
- facilitate Risk Management Case Studies for training purposes

Subelement YA- Space and Terrestrial Environments Support (Revision 1 update)

Assess program definition and/or requirements to determine applicable space environments. Engineers will assess the mission characteristics (orbit, launch data, duration, operations, etc.) and spacecraft design (materials, power system voltages, component specifications, etc.) to identify relevant ionizing radiation environments. Assessment will use expertise in spacecraft mission analysis, spacecraft design, risk management, and natural and induced space environments.

Define the space environment and environment effects. Definition of the environment for the spacecraft/mission will be performed using models/databases of the environments and/or scientific expertise. Assessment of the environment effects will be performed using engineering expertise and the appropriate models. The models themselves will be reviewed and updated as new data become available.

Provide inputs to requirements, specifications, and designs. Prepare reports, briefing, and project documentation that documents the analyses performed in support of the project. Additional outputs will include an analysis of the available component radiation response data to permit a determination of the suitability for use in the ionizing radiation environment. This will be performed using models of the environments and/or scientific expertise, and available component radiation test data.

The ESTS Group will participate in design and safety reviews scheduled by the MSFC Project Office. This participation may include the review of design data and analyses and the development of Review Item Discrepancies (RIDs). Each RID written by the ESTS Group will be coordinated with the MSFC Task Initiator. The ESTS Group will also respond to bring to closure RIDs written against data and analyses submitted by the ESTS Group.

3.0 Discussion of Skills Required

Subelement AA-Ares V Core Stage

Personnel should have intensive knowledge, understanding and experience of structural design methods, material behavior and fabrication methods; also familiarity of launch vehicle systems (Structures, Separation, Propulsion, Pressurization, Cryogenic Propellant Behavior, Thermal Protection Performance, Debris Impact, etc.) is highly desired.

Skills also require ability to create technical reports and creation of schedules for follow up of design reviews, System Requirements reviews, and other engineering activities using documents from others.

Skill in project coordination in an IPT team environment to participate on a team of engineers with expertise in thermal design and analysis, materials (metallic and non-metallic), aero-sciences, manufacturing and producibility, and work with supporting IPT personnel in areas such as structural design and analysis, Main Propulsion System, Reaction Control System, Quality Control, Ground Support System, Safety and Mission Assurance and Reliability and System Engineering and Integration.

Knowledge in structural analysis, vehicle trajectory, thermal protection systems, and thermal controls and materials is preferred.

Personnel involved in this project should have mechanical design experience in space structures, mechanisms, and/or fluid systems. CAD experience using a high-end CAD package is desirable. Some systems level skill regarding project management would also be helpful.

Subelement AB-Ares V Vehicle Integration

Personnel should have intensive knowledge, understanding and experience of structural design methods, material behavior and fabrication methods; also familiarity of launch vehicle systems (Structures, Separation, Propulsion, Pressurization, Cryogenic Propellant Behavior, Thermal Protection Performance, Debris Impact, etc.) is highly desired.

Skills also require ability to create technical reports and creation of schedules for follow up of design reviews, System Requirements reviews, and other engineering activities using documents from others.

Skill in project coordination in an IPT team environment to participate on a team of engineers with expertise in thermal design and analysis, materials (metallic and non-metallic), aero-sciences, manufacturing and producibility, and work with supporting IPT personnel in areas such as structural design and analysis, Main Propulsion System, Reaction Control System, Quality Control, Ground Support System, Safety and Mission Assurance and Reliability and System Engineering and Integration.

Knowledge in structural analysis, vehicle trajectory, thermal protection systems, and thermal controls and materials is preferred.

Personnel involved in this project should have mechanical design experience in space structures, mechanisms, and/or fluid systems. CAD experience using a high-end CAD package is desirable. Some systems level skill regarding project management would also be helpful.

Subelement AC-Ares V 1st Stage

Personnel should have intensive knowledge, understanding and experience of structural design methods, material behavior and fabrication methods; also familiarity of launch vehicle systems (Structures, Separation, Propulsion, Pressurization, Cryogenic Propellant Behavior, Thermal Protection Performance, Debris Impact, etc.) is highly desired.

Skills also require ability to create technical reports and creation of schedules for follow up of design reviews, System Requirements reviews, and other engineering activities using documents from others.

Skill in project coordination in an IPT team environment to participate on a team of engineers with expertise in thermal design and analysis, materials (metallic and non-metallic), aero-sciences, manufacturing and producibility, and work with supporting IPT personnel in areas such as structural design and analysis, Main Propulsion System, Reaction Control System, Quality Control, Ground Support System, Safety and Mission Assurance and Reliability and System Engineering and Integration.

Knowledge in structural analysis, vehicle trajectory, thermal protection systems, and thermal controls and materials is preferred.

Personnel involved in this project should have mechanical design experience in space structures, mechanisms, and/or fluid systems. CAD experience using a high-end CAD package is desirable. Some systems level skill regarding project management would also be helpful.

Subelement AD- Aerosciences Support for Ares V Vehicle Integration

An experience base in Aerosciences environments and characteristics, wind tunnel testing, empirical estimation, and development of flight design Aerosciences databases is required. Familiarity with historical launch vehicle characteristics and environments in Aerosciences disciplines is also required.

Subelement AE- Ares V Requirements Definition

Personnel with systems engineering, project engineering, requirements definition and development, and functional flow development will support the task team to meet program and customer schedules.

Subelement AF-Ares V Vehicle Integration Support

Task personnel shall include a mix of system engineers with backgrounds in various discipline specialties and experience supporting space systems development in all life-cycle phases.

Subelement AG-Ares V Knowledge Management Support (Revision 1 addition)

Task personnel will be experienced in systems engineering, knowledge capture and process development for space vehicle systems and subsystems.

Subelement CA-Integrated Test and Evaluation Support

Task personnel shall include engineers with a Bachelor of Science degree in a related engineering field or engineering discipline synergistic with test or space vehicle design (e.g., aerospace, electrical, mechanical, physics, propulsion, engineering science, chemical, etc.). The Task personnel shall have knowledge of launch vehicle performance analyses, the Ares I project and engineering organizations, component level and integrated systems testing (qualification and acceptance), SSP 41172 requirement compliance (hardware qualification/acceptance testing), NASA test and verification boards, design requirement verification, and in classical systems engineering (i.e., requirements development, systems engineering management planning, test planning, development of review plans, design coordination, development of figures of merit, etc.). Knowledge of the Ares I-X mission is extremely valuable. Technical writing skills required. Self-starting individual with presentation skills required.

Subelement CB- FS Structural Stress Support

This subelement requires broad experience in structural strength, fracture mechanics and fatigue analysis and modeling. The subelement may also require skill in finite element methods using software such as NASTRAN/PATRAN, FEMAP, or ABAQUS using on-site computers.

Subelement CC-FS Structural Design Support

Skills include general ability to model concept designs using CAD package. Personnel should be capable of utilizing Microsoft Office software. Personnel should have familiarity with the use of PDM systems. The ability to create and manipulate Excel spreadsheets and PowerPoint presentations is required. Personnel involved in this project should have mechanical design experience in space structures, mechanisms, and/or fluid systems. Solid Rocket Booster (SRB) experience is desired. Also CAD experience in using a high-end CAD package, (Pro-E). Skills should include the ability to provide drawing layouts and technical reports/presentations to MSFC and outside vendors. It is highly desirable that personnel have CAD experience using 3D software and the competence to either use or be trained to use top-down modeling techniques. Some systems level skill regarding project management would also be helpful.

Personnel should have intensive knowledge, understanding and experience of structural design methods, material behavior and fabrication methods; also familiarity of launch vehicle systems (Structures, Separation, Propulsion, Pressurization, Cryogenic Propellant Behavior, Thermal Protection Performance, Debris Impact, etc.)

Subelement CD- FS Aeroscience Support (Revision 1 deletion)

An experience base in Aerosciences environments and characteristics, wind tunnel testing, empirical estimation, and development of flight design Aerosciences databases is required. Familiarity with historical launch vehicle characteristics and environments in Aerosciences disciplines is also required.

Subelement CF- Booster Re-entry Analysis

Extensive experience in Shuttle SRB entry simulation, trajectory analysis, dynamics, computer coding, and an understanding of computer simulations is desired. FORTRAN is required, C is desirable. Microsoft Office and UNIX operating system proficiency is needed. Excellent written and oral communications skills as well as excellent computer skills are required. Excellent interpersonal skills required.

Subelement CG- First Stage System Engineering & Integration Support

This Subelement requires experience in the integration of solid rocket propulsion systems and extensive experience in the system, testing and project engineering fields.

Subelement CJ- Analysis and Concept Development Support

This Subelement requires experience in working with a design team, and with launch vehicle configuration, design and analysis. Expertise with launch vehicle systems, experience in physical and virtual simulation, and expertise in concept development design and analysis is required. Knowledge of Design and Data Management System (DDMS) Windchill and virtual simulation software packages, Delmia D5 (minimum), Delmia V5 (thorough), Division Mockup, is required for translation and use of CAD models from Vehicle Project Designers to incorporate into subjected virtual scenarios, and in conjunction with physical mockup analyses, for aid in analysis and concept development. Knowledge of CAD system (ProE), human interface and kinematics modeling is required. Expertise in the area of integrated performance analysis of human rated launch vehicles, modeling and simulation, schematics, vehicle performance analysis, and flight/orbital mechanics analysis is required. Experience with mass properties software tools and the ability to use Computer Aided Design (CAD) tools to develop and assess mass properties data is required. Knowledge of human to system interfaces with specific experience in Human Factor Engineering is required. Experience in the design, planning and construction of physical mockups is required.

Subelement CL- US Structural Stress Support

This subelement requires broad experience in structural strength, fracture mechanics and fatigue analysis and modeling. The subelement may also require skill in finite element methods using software such as NASTRAN/PATRAN, FEMAP, or ABAQUS using on-site computers.

Subelement CM- US Structural Design Support

Skills include general ability to model concept designs using CAD package. Personnel should be capable of utilizing Microsoft Office software. Personnel should have familiarity with the use of PDM systems. The ability to create and manipulate Excel spreadsheets and PowerPoint presentations is required. Personnel involved in this project should have mechanical design experience in space structures, mechanisms, and/or fluid systems.

Personnel involved in this project will have a Mechanical Engineering Degree, understanding and experience of structural design methods, material behavior and fabrication methods. Skill in project coordination in an IPT environment is preferred. Familiarity of launch vehicle systems (Structures, Separation, Propulsion, Pressurization, Cryogenic Propellant Behavior, Thermal Protection Performance, Debris Impact, etc.) is desirable.

Skills include ability to model conceptual designs in three dimensions using ProEngineer CAD software system to produce layout drawings and production drawings for use by manufacturing, quality control and ground support equipment. Skills also require the ability to create technical reports and creation of schedules for follow up of design reviews, System Requirements reviews, and other engineering activities using documents from others.

Subelement CN- Upper Stage System Design Support

Experience in systems engineering with background in various discipline specialties and experience supporting space systems development in all life-cycle phases is required. Experience in project engineering, integration, Earned Value Management, Cradle, and technical writing to meet program and customer schedules is required.

Subelement CP- VI Structural Dynamics and Loads Support

As a minimum, must have a bachelors degree in Aerospace Engineering, Mechanical Engineering, Civil Engineering or equivalent. Extensive background and experience in dynamic analysis of space flight vehicles, space vehicle ground support systems, rocket propulsion system components and/or other aerospace vehicles is strongly desired. The task order requires, as a desired minimum, skill in NASTRAN for dynamics analysis work (including modeling, Superelement processing, Direct Matrix Abstraction Program (DMAP) generation, and frequency response and transient analyses), use of Patran pre-/post-processing software (when utilizing on-site computers) and use of hydroelastic (HYDRO) tools. Capability to develop and run simulations and perform Monte Carlo analyses is desired. Extensive capability and broad experience in high frequency loads and dynamic analysis is required, including deriving and processing Fast-Fourier Transforms (FFTs) and Power Spectral Densities (PSDs), performing probability and confidence statistical analysis, and formulating vibroacoustic, acoustic and shock test criteria for design and test. Extensive knowledge of the VA-One tool to conduct Statistical Energy Analysis (SEA) and Hybrid SEA vibroacoustic analysis is required. Knowledge of classical vibroacoustic scaling methods and tools is required. Knowledge of shock analysis tools is required. Broad experience in analysis for vehicle ground vibration test (GVT) testing and flight testing is required. Knowledge of the Effective Independence (EFI) Method, the Modal Assurance Criteria (MAC) and the Cross-Orthogonalization (XOR) tools and methods for vehicle flight testing and ground testing instrumentation selection is required. Knowledge of Matlab is required. Capability and experience in FORTRAN and FORTRAN FORMA codes is required. Knowledge of C is desirable. Knowledge of Excel and Visual Basic is desirable. Knowledge of FEMAP and/or Hypermesh tools is desirable. Ability to generate clear and concise presentations and technical reports is required. FEMAP and/or Hypermesh tools is desirable. Ability to generate clear and concise presentations and technical reports is required.

Subelement CR- Vehicle Structural Design Integration

Personnel involved in this project should have mechanical design experience in space structures, mechanisms, and/or fluid systems. CAD experience using Pro-E software is desirable. Some systems level skills regarding project management would also be helpful. Personnel should be capable of utilizing Microsoft Office software. Personnel should have familiarity with the Windchill PDM system.

Subelement CS- VI Aeroscience Support

An experience base in aerodynamics, APAS and CBAERO, wind tunnel testing, empirical estimation, principle of superposition, and development of flight aerodynamic database is required. Familiarity with historical launch vehicle aerodynamics, venting, and development is also required.

An experience base in aerodynamic heating, plume environments, MINIVER and STATE for aeroheating, wind tunnel testing, empirical estimation, and development of flight design databases is required. Familiarity with historical launch vehicle aerothermodynamics and development is also required.

A strong background in conducting experimental and theoretical/computational analyses of unsteady fluid dynamics and aerodynamics of space transportation vehicles using state-of-the-art experimental methods and tools is highly desired.

Experience in all phases (planning through analysis and documentation of results) of test programs is required. Experience with MATLAB and FORTRAN and proficiency in C are highly desired for the development of new, or modification to, current computational tools and pre- and post-processing utilities. In addition, experience in writing macros in Excel's Visual Basic for Applications (VBA) is highly desired.

Experience in performing acoustic analysis is required.

Subelement CT- GN&C Flight Control Design & Analysis

Qualifications include experience in systems engineering, design and development of GN&C system hardware including sensors, actuators, and data systems. Should also have experience in GN&C algorithm development along with flight software design, development and testing.

- Minimum of a BS, MS, or PhD in Aerospace or Mechanical Engineering from an ABET accredited school and a minimum of 10+ years experience in space flight hardware development. Experience with Guidance Navigation & Control (GN&C) hardware is required. Knowledge and experience in writing requirements and verifications is required.
- Requires in-depth experience in modeling and simulation, in particular: Integration of models in the Pogo stability analysis tool simulation environment; enhancement of the Pogo stability analysis tool; and the Pogo stability analysis tool configuration management and control process. Excellent written and oral communications skills as well as excellent computer skills and interpersonal skills are required.

Subelement CU- GN&C and Navigation Design, Analysis and Modeling

Engineering support with skills in the C programming language, MATLAB, Microsoft Office, and UNIX operating system is needed. Knowledge of Kalman Filters, Orbital Mechanics, and Guidance and Control Systems is desired. Extensive experience in Shuttle RSRB ascent/entry simulation, launch vehicle trajectory analysis, computer coding capability, and an understanding of computer simulations is desired. FORTRAN is required; C is desirable. Microsoft Office and UNIX operating system proficiency is needed. Written and oral communications skills as well as excellent computer skills are required. Must also be able to effectively interact with the customer and other contractors.

- Personnel must either have at least two years of industrial experience specifically in vehicle navigation systems or have an M.S. or Ph.D. degree in the field of vehicle navigation with a research topic related to vehicle navigation. The contractor shall be capable of developing equations, algorithms, and software tools suitable for navigation system analysis, simulation, and design in Simulink independently.
- Extensive experience in GN&C algorithm development and simulation, along with flight software design, development and testing is required. Extensive experience in C and C++ coding is required. Microsoft Office and UNIX operating system proficiency is needed. Excellent written and oral communications skills as well as excellent computer skills and interpersonal skills are required. In-depth experience in integrating models in the MAVERIC II simulation environment, enhancement of the MAVERIC II simulation environment and the MAVERIC II configuration management and control process is required.

Subelement CV- Health Management Design & Analysis

A mix of junior and senior level engineers with vehicle, subsystem, operations, sensors and test experience is required. Personnel should be capable of utilizing Microsoft Office software, TEAMS, Matlab, and/or Simulink. The ability to create and manipulate Excel spreadsheets and PowerPoint presentations is required.

Subelement CW- Vehicle Systems Design Integration

Task personnel shall include a mix of system engineers with backgrounds in various discipline specialties and experience supporting space systems development in all life-cycle phases. Personnel shall have experience in the support of major NASA or other government and industry requirement development activities and functional flow development. Personnel shall be proficient in required software applications. Personnel with project engineering, integration, and technical writing will support the core system engineering task team as needed to meet program and customer schedules.

Subelement CX- VI Design Analysis and Integration

Task personnel shall include junior to senior level engineers or equivalent experience and requires knowledge of analytical integration practices with specific experience in the areas of operability, probabilistic design analysis, and general systems engineering. Tasks require experience with

physics-based modeling using software tools such as MATLAB. Additional system engineers with backgrounds in various discipline specialties and experience supporting space systems development in all life-cycle phases. Personnel with project engineering, project coordination, integration, and scheduling will support the task team to meet program and customer schedules.

Subelement CY- Vehicle Development and Flight Evaluation

Task personnel shall include system engineers with backgrounds in various discipline specialties and experience supporting space systems development, project engineering, integration, earned-value management, schematic drawing(s) development and technical writing skills at a level to perform the subtasks in this order and support the core system engineering task team as needed to meet program and customer schedules.

Subelement CZ- Knowledge Management (KM) Support

Task personnel will be a blend of experienced system engineers and risk management engineers and professionals with experience in Space systems. Task personnel will provide system management support for the programs and projects of interest utilizing proven system engineering and project management processes and techniques.

Subelement DA-1st Stage Structural Dynamics and Loads Support

As a minimum, must have a bachelors degree in Aerospace Engineering, Mechanical Engineering, Civil Engineering or equivalent. Extensive background and experience in finite element modeling, dynamic analysis, loads analysis and environments modeling and analysis of space flight vehicles, space vehicle ground support systems, rocket propulsion system components and/or other aerospace vehicles is strongly desired. The task order requires, as a desired minimum, skill in NASTRAN for dynamics analysis work (including modeling, modal analysis, frequency response analysis and transient response analysis), use of PATRAN pre-/post-processing software (when utilizing on-site computers) and use of hydroelastic (HYDRO) tools. Capability to develop and run simulations and perform Monte Carlo analyses is desired. Extensive capability and broad experience in high frequency loads and dynamic analysis is required, including deriving and processing Fast-Fourier Transforms (FFTs) and Power Spectral Densities (PSDs), performing probability and confidence statistical analysis, and formulating vibroacoustic, acoustic and shock test criteria for design and test. Extensive knowledge of the Auto-SEA VA-One tool to conduct Statistical Energy Analysis (SEA) and Hybrid SEA vibroacoustic analysis is required. Knowledge of classical vibroacoustic scaling methods and tools is required. Knowledge of shock analysis tools is required. Broad experience in analysis for ground vibration test (GVT) testing and flight testing is required. Knowledge of the Effective Independence (EFI) Method, the Modal Assurance Criteria (MAC) and the Cross-Orthogonalization (XOR) tools and methods for vehicle flight testing and ground testing instrumentation selection is required. Knowledge of component analysis and testing is required. Knowledge of Matlab is required. Capability and experience in FORTRAN and FORTRAN FORMA codes is desirable.

Experience with LS-DYNA software is desirable. Knowledge of C is desirable. Knowledge of Excel and Visual Basic is desirable. Knowledge of FEMAP and/or Hypermesh tools is desirable.

Subelement DB- Integrated Engineering Process Planning (Revision 1 addition)

Personnel will include senior level engineers with subject matter expertise in NASA systems management, systems engineering and project management. Additionally personnel will have proven expertise in the support of NASA efforts in the use, adaptation and application of knowledge capture and management for documenting program and project lessons learned.

Subelement EA-LAS Risk Management

Task personnel will be a blend of experienced system engineers and risk management engineers and professionals with experience in Aerospace hardware and Space systems. Task personnel will provide system management support for the programs and projects of interest utilizing proven system engineering and project management processes and techniques. Where specialized techniques are involved, Subject Matter Experts will be sought out to provide the best capability and efficiency for the NASA customer to provide direct support and customer education in the methodology utilized.

Subelement YA- Space and Terrestrial Environments Support (Revision 1 update)
Engineers/scientists with degrees in space physics, physics, electrical engineering, aerospace engineering, or equivalent. Relevant experience includes space environments and effects, skill in applying complex engineering models and databases associated with natural and induced space environments including ionizing radiation environment definition, and ionizing radiation effects on EEE (electronic, electrical, electromechanical) parts. Experience in space environments (e.g. magnetosphere, solar wind, and solar energetic particles) and their effects on spacecraft systems and subsystems. Experience with relevant space environment codes, analysis of space environment data, and the ability to develop new environment codes is desired.

4.0 Special Tools Required

Subelement AA-Ares V Core Stage
An SE2 CPU (64 bit) assembled with appropriate graphics card to render graphics created with complex ProEngineer CAD software system. Hardware and software capable of supporting computer aided design.

Access to the DDMS Windchill PDM system is required. Access to the ICE Windchill system is also required.

Subelement AB-Ares V Vehicle Integration
An SE2 CPU (64 bit) assembled with appropriate graphics card to render graphics created with complex ProEngineer CAD software system. Hardware and software capable of supporting computer aided design.

Access to the DDMS Windchill PDM system is required. Access to the ICE Windchill system is also required.

Subelement AC-Ares V 1st Stage
An SE2 CPU (64 bit) assembled with appropriate graphics card to render graphics created with complex ProEngineer CAD software system. Hardware and software capable of supporting computer aided design.

Access to the DDMS Windchill PDM system is required. Access to the ICE Windchill system is also required.

Subelement AD- Aerosciences Support for Ares V Vehicle Integration
MATLAB, Sinda/FLUENT, CHCHVENT, APAS, CBAERO, CART3D, VAEPP, PLIMP, MINIVER, STATE, LOCI, LOCI-CHEM, and other CFD solvers.

Subelement CB- FS Structural Stress Support (Revision 1 deletion)

Subelement CC-FS Structural Design Support
An SE2E CPU (64 bit) assembled with appropriate graphics card to render appropriate graphics created with complex ProEngineer CAD software system. Hardware and software capable of supporting computer aided design of composite parts. Access to the Team Center PDM and Windchill PDM system is required

Subelement CJ- Analysis and Concept Development Support
Division Mockup is required for analysis and 3 dimensional representation of the integrated element. Design Engineering software; shop equipment including but not limited to hand tools, table saws, drill press, materials lift and accessibility equipment to support mockup development.

Subelement CM- US Structural Design Support

An SE2 CPU (64 bit) assembled with appropriate graphics card to render graphics created with complex ProEngineer CAD software system. Hardware and software capable of supporting computer aided design of composite parts.
Access to the DDMS Windchill PDM system is required. Access to the ICE Windchill system may also be required.

Subelement CR- Vehicle Structural Design Integration
Access to the Windchill PDM system and the Pro-E software is required. Access to CAD software compatible with systems used by 1st stage and CEV contractors and vendors is required. High-end CAD workstation capable of handling massive assemblies is necessary.

Subelement CS- VI Aeroscience Support
MATLAB, Sinda/FLUENT, CHCHVENT, APAS, CBAERO, CART3D, VAEPP, PLIMP, MINIVER, STATE, LOCI, LOCI-CHEM, and other CFD solvers. Microsoft Project 2007 (Government furnished)

Subelement CX- VI Design Analysis and Integration
MATLAB (Government furnished)

Subelement EA-LAS Risk Management
Microsoft Project 2007 (Government furnished)
Milestones Software (Government furnished)
Constellation Integrated Risk Management Application (Government furnished)
Adobe Acrobat Professional

5.0 Participating Subcontractors (Revision 1 update)

Subelement AE- Ares V Requirements Definition
(b)(4)

Subelement CG- First Stage System Engineering & Integration Support
(b)(4)

Subelement CS- VI Aeroscience Support
(b)(4)

Subelement CT- GN&C Flight Control Design & Analysis
(b)(4)

Subelement CU- GN&C and Navigation Design, Analysis and Modeling DCI
(b)(4)

Subelement CV- Health Management Design & Analysis
(b)(4)

Subelement CX- VI Design Analysis and Integration
(b)(4)

Subelement CZ- Knowledge Management Support (Revision 1 addition)
(b)(4)

Subelement DB- Integrated Engineering Process Planning (Revision 1 addition)

(b)(4)

Subelement YA- Space and Terrestrial Environments Support (Revision 1 update)
(b)(4)

6.0 Milestones & Deliverables

Subelement AA-Ares V Core Stage
Engineering data will be delivered in electronic and/or paper media format. Deliverables include, but are not limited to presentations and CAD models, and involve design updates, reviews, and drawings. It will be the responsibility of the MSFC Initiator to create appropriate fabrication requests and provide document control over the deliverables provided by this subtask.

Support Reviews, Data Releases and other milestones as requested by IPT lead. Dates for deliverables and milestones will be negotiated for each individual vehicle design/analysis assignment as they develop.

Monthly Activity Reports (MARs) and Monthly Financial Reports with updated schedules and resource utilization charts will be prepared and provided via the on-line Jacobs ESTS Group web site.

Subelement AB-Ares V Vehicle Integration
Engineering data will be delivered in electronic and/or paper media format. Deliverables include, but are not limited to presentations and CAD models, and involve design updates, reviews, and drawings. It will be the responsibility of the MSFC Initiator to create appropriate fabrication requests and provide document control over the deliverables provided by this subtask.

Support Reviews, Data Releases and other milestones as requested by IPT lead. Dates for deliverables and milestones will be negotiated for each individual vehicle design/analysis assignment as they develop.

Monthly Activity Reports (MARs) and Monthly Financial Reports with updated schedules and resource utilization charts will be prepared and provided via the on-line Jacobs ESTS Group web site.

Subelement AC-Ares V 1st Stage
Engineering data will be delivered in electronic and/or paper media format. Deliverables include, but are not limited to presentations and CAD models, and involve design updates, reviews, and drawings. It will be the responsibility of the MSFC Initiator to create appropriate fabrication requests and provide document control over the deliverables provided by this subtask.

Support Reviews, Data Releases and other milestones as requested by IPT lead. Dates for deliverables and milestones will be negotiated for each individual vehicle design/analysis assignment as they develop.

Monthly Activity Reports (MARs) and Monthly Financial Reports with updated schedules and resource utilization charts will be prepared and provided via the on-line Jacobs ESTS Group web site.

Subelement AD- Aerosciences Support for Ares V Vehicle Integration
Monthly Activity Reports will be required. Other deliverables will be technical reports tied to program analyses and reviews.

Subelement AE- Ares V Requirements Definition
System Engineering and Project Engineering products will be delivered to meet the schedule as supported by this function.

Monthly reports of activity and accomplishments are required.

Subelement AF-Ares V Vehicle Integration Support
System Engineering and Project Engineering products will be delivered to meet the schedule as supported by this function.

Monthly reports of activity and accomplishments are required.

Subelement AG-Ares V Knowledge Management Support (Revision 1 addition)
Monthly reports of activity and accomplishments are required. Final documents will be delivered to meet schedule needs as negotiated by the task initiator or their designated representative. Monthly reporting will be provided by customer work package area support.

Subelement CA-Integrated Test and Evaluation Support
Monthly Activity Reports will be required. Other deliverables will be technical reports tied to program analyses and reviews.

Subelement CB- FS Structural Stress Support
Provide technical comments and findings in the form of email, memoranda, or technical presentations as appropriate. Results of any Independent analysis will be provided in the form of data files, briefing charts, and technical reports. Monthly Activity Reports will be prepared to include a current schedule of anticipated and completed work as well as description of the work performed in the current period of performance. Access to all technical documents, analysis models, analytical results, and inputs files will be provided to EV31.

Subelement CC-FS Structural Design Support
Monthly Activity Reports (MARs) and Monthly Financial Reports with updated schedules and resource utilization charts will be prepared and provided via the on-line Sverdrup Technology MSFC Group web site. Engineering data will be delivered in electronic and/or paper media format. Deliverables include, but are not limited to presentations and CAD models, and involve design updates, reviews, and drawings.
It will be the responsibility of the MSFC Initiator to create appropriate fabrication requests and provide document control over the deliverables provided by this subtask.
Support Reviews, Data Releases and other milestones as requested by IPT lead. Dates for deliverables and milestones will be negotiated for each individual vehicle design/analysis assignment as they develop. Deliverables will be technical reports tied to program analyses and reviews as agreed to with the program. Deliverables will be technical reports tied to program analyses and reviews as agreed to with the program.

Subelement CD- FS Aeroscience Support (Revision 1 deletion)
Monthly Activity Reports will be required. Other deliverables will be technical reports tied to program analyses and reviews.

Subelement CF- Booster Re-entry Analysis
Activity reports - Monthly
Provide reports and design recommendations - As coordinated with EV41

Subelement CG- First Stage System Engineering & Integration Support
Activity reports - Monthly

Subelement CJ- Analysis and Concept Development Support

- Activity reports - Monthly
- Provide reports and design recommendation - As coordinated with EV41
- Re-entry Rupture Analysis - US Interim Design Review
- Integrated System Schematic - Quarterly
- Mass Properties Report - Quarterly/US Interim Design Review

- Gross Task Analysis - US Interim Design Review
- Analysis Report for Aft Skirt Work Site Analysis - US Interim Design Review
- Analysis Report for Thrust Cone Work Site Analysis - US Interim Design Review

Subelement CL- US Structural Stress Support
Monthly Activity Reports will be prepared to include a current schedule of anticipated and completed work as well as description of the work performed in the current period of performance. Access to all technical documents, analysis models, analytical results, and inputs files will be provided to EV31.

Subelement CM- US Structural Design Support
Monthly Activity Reports (MARs) and Monthly Financial Reports with updated schedules and resource utilization charts will be prepared and provided via the on-line ESTS Group web site.

Engineering data will be delivered in electronic and/or paper media format. Deliverables include, but are not limited to presentations and CAD models, and involve design updates, reviews, and drawings. It will be the responsibility of the MSFC Initiator to create appropriate fabrication requests and provide document control over the deliverables provided by this task.

Support Reviews, Data Releases and other milestones as requested by subsystem lead. Dates for deliverables and milestones will be negotiated for each individual vehicle design/analysis assignment as they develop. Most notably, this task has the primary responsibility for reviews of the Thermal Protection System and the Integrated Structures. Also, all sub-elements will support Upper Stage and Ares I reviews as required.

This task will deliver layout packages, detail part and assembly drawings, and associated 3-D models for Upper Stage Structures and TPS flight hardware, as well as test article drawings for Structural Development and Thermal Development tests. The layout packages will include 3-D CAD models, associated layout drawings, and a design notebook with details of the design including driving requirements, appropriate thermal, stress, and dynamic analyses, and testing and manufacturing considerations. This task will also coordinate inputs for the purge, vent, and hazardous gas detection systems, pyrotechnics and separation systems, ground umbilical connections, and secondary structure design.

Subelement CN- Upper Stage System Design Support
Activity reports - Monthly
Natural Environments Requirements Sensitivity - US Interim Design Review
Applicability Plan - US Interim Design Review

Subelement CP- VI Structural Dynamics and Loads Support
Provide and deliver to MSFC/EV31 monthly technical reports and subtask technical written reports in memo form, no later than 1.5 months after completion of a task, for industry publication or documentation of work performed.

- Provide technical memos and presentations.
- Provide analysis results in the form of data files, briefing charts, and reports.
- Provide model deliverables, as a minimum, in the form of well-documented data files (i.e NASTRAN .blk files). Include status reports and/or briefing charts as required.
- Provide Monthly Activity Reports (MARs) that include task accomplishments, task schedules and financial data.

Provide government access to all models, analyses, results and inputs files, electronically.

Subelement CR- Vehicle Structural Design Integration
Monthly Activity Reports (MARs) with updated schedules and resource utilization charts will be prepared. Engineering data will be delivered in electronic and/or paper media format. It will be the

responsibility of the MSFC Initiator to provide document control over the deliverables provided by this subtask. Deliverables to be produced during execution of this Task Order shall include an integrated CAD assembly, and an OML of the assembly. All drawing delivery dates are the available date (release or Design State) into DDMS for approval.

Subelement CS- VI Aeroscience Support

Monthly Activity Reports will be required. Other deliverables will be technical reports tied to program analyses and reviews.

Subelement CT- GN&C Flight Control Design & Analysis

- Activity reports - Monthly
- Documentation of all definition, derivation and analyses performed in support of the EV and EV41 requirements, specifications, and error budget developments - As coordinated with EV41
- Flight control design, analysis and simulation inputs - As coordinated with EV41
- Inputs to Roll Control issues - As coordinated with EV41
- Software source codes and model updates - as developed
- Configuration management documentation - Monthly
- Configuration management statistics of Pogo stability analysis tool and model updates - Monthly

Subelement CU- GN&C and Navigation Design, Analysis and Modeling

- Activity reports - Monthly
- Trajectory documentation, performance analysis, trade studies, model and report review, and requirement review support – Monthly
- Status reports describing the technical progress and findings - Monthly
- Mathematical equations, models, algorithms and software source codes - As coordinated with EV42
- Configuration Management records and monthly statistics - As coordinated with EV42
- Software source codes developed for the task - As coordinated with EV42

Subelement CV- Health Management Design & Analysis

- Activity reports - Monthly
- Vehicle integration definition and analysis - As coordinated with EV43
- FFA analysis, verification and validation planning - As coordinated with EV43
- Upper Stage and First Stage algorithm definition and analysis - As coordinated with EV43
- Presentations and documents - As coordinated with EV43

Subelement CW- Vehicle Systems Design Integration

Monthly Activity Reports

Products required will be delivered to support milestones outlined in the Integrated Master Schedule. Final Activity Report/Briefing will be delivered at the end of the period of performance

Subelement CX- VI Design Analysis and Integration

Probabilistic Design Analysis Models and documentation will be delivered to support vehicle design concerns and programmatic reviews - Checkpoint Reviews, Peer Reviews, Preliminary Design Review (PDR) and Critical Design Review (CDR). System Engineering and Project Engineering products will be delivered to meet the schedule as supported by this function.

Subelement CY- Vehicle Development and Flight Evaluation

Monthly Activity Reports will be required. Other deliverables will be technical reports tied to program analyses and reviews.

Subelement CZ- Knowledge Management (KM) Support

Monthly reports of activity and accomplishments are required. Final documents will be delivered to meet schedule needs as negotiated by the task initiator or their designated representative. Monthly reporting will be provided by customer work package area support.

Subelement DA-1st Stage Structural Dynamics and Loads Support

(a) Provide and deliver to MSFC/EV31 monthly technical reports and subtask technical written reports in memo form, no later than 1.5 months after completion of a task, for industry publication or documentation of work performed.
(b) Provide technical memos and presentations.
(c) Provide analysis results in the form of data files, briefing charts, and reports.
(d) Provide model deliverables, as a minimum, in the form of well-documented data files (i.e NASTRAN .blk files). Include status reports and/or briefing charts as required.
(e) Provide Monthly Activity Reports (MARs) that include task accomplishments, task schedules and financial data.

Provide government access to all models, analyses, results and inputs files, electronically.

Subelement DB- Integrated Engineering Process Planning (Revision 1 addition)

Monthly reports of activity and accomplishments are required. Final documents will be delivered to meet schedule needs as negotiated by the task initiator or their designated representative. Monthly reporting will be provided by customer work package area support.

Subelement EA-LAS Risk Management

Monthly reports of activity and accomplishments are required.

Final documents (briefings and reports) will be delivered to meet schedule needs, as negotiated by the task initiator or their designated representative and recorded as a part of the monthly activity report.

Subelement YA- Space and Terrestrial Environments Support (Revision 1 update)

Products include monthly activity reports, computer models, spacecraft and geophysical data analyses, design analyses, Review Item Discrepancies, test plans, test data analyses, presentations, and technical papers where appropriate. Delivery dates and milestones, specific to individual programs and projects, will be completed, as required, to meet program and project schedule requirements.

7.0 Special Considerations (Recruiting, Special Equipment / Material, Safety, etc.)

Subelement CC-FS Structural Design Support

Travel is estimated for three trips to JSC.

Subelement CG- First Stage System Engineering & Integration Support

Travel is estimated for six trips to JSC and/or KSC.

Subelement CJ- Analysis and Concept Development Support (Revision 1 update)

Material is estimated to cover material for Performance Analysis Design Demonstrators (PADDs). Other is estimated to cover personal protection equipment (steel toed shoes).

Subelement CN- Upper Stage System Design Support

Travel is estimated for two trips for technical interchange meetings.

Subelement CP- VI Structural Dynamics and Loads Support

Travel for 6 trips to attend technical interchange and AIAA Technical Committee meetings is anticipated and is included in the Cost Estimate.

Training for LMS, Advanced SEA Hybrid, LSDyna and Advanced DMAP MSC is estimated and included as Other in the Cost Estimate.

Subelement CR- Vehicle Structural Design Integration
Travel is estimated for two trips to JSC.

Subelement CS- VI Aeroscience Support (Revision 1 update)
Travel is estimated for four trips to support wind tunnel tests at various sites across NASA and for conference attendance. Other costs are included for participation for AIAA and JANNAF conferences.

Subelement CX- VI Design Analysis and Integration
Travel is estimated for three trips for technical interchange meetings.

Subelement DA- 1st Stage Structural Dynamics and Loads Support
Travel is estimated for two trips for technical interchange meetings.

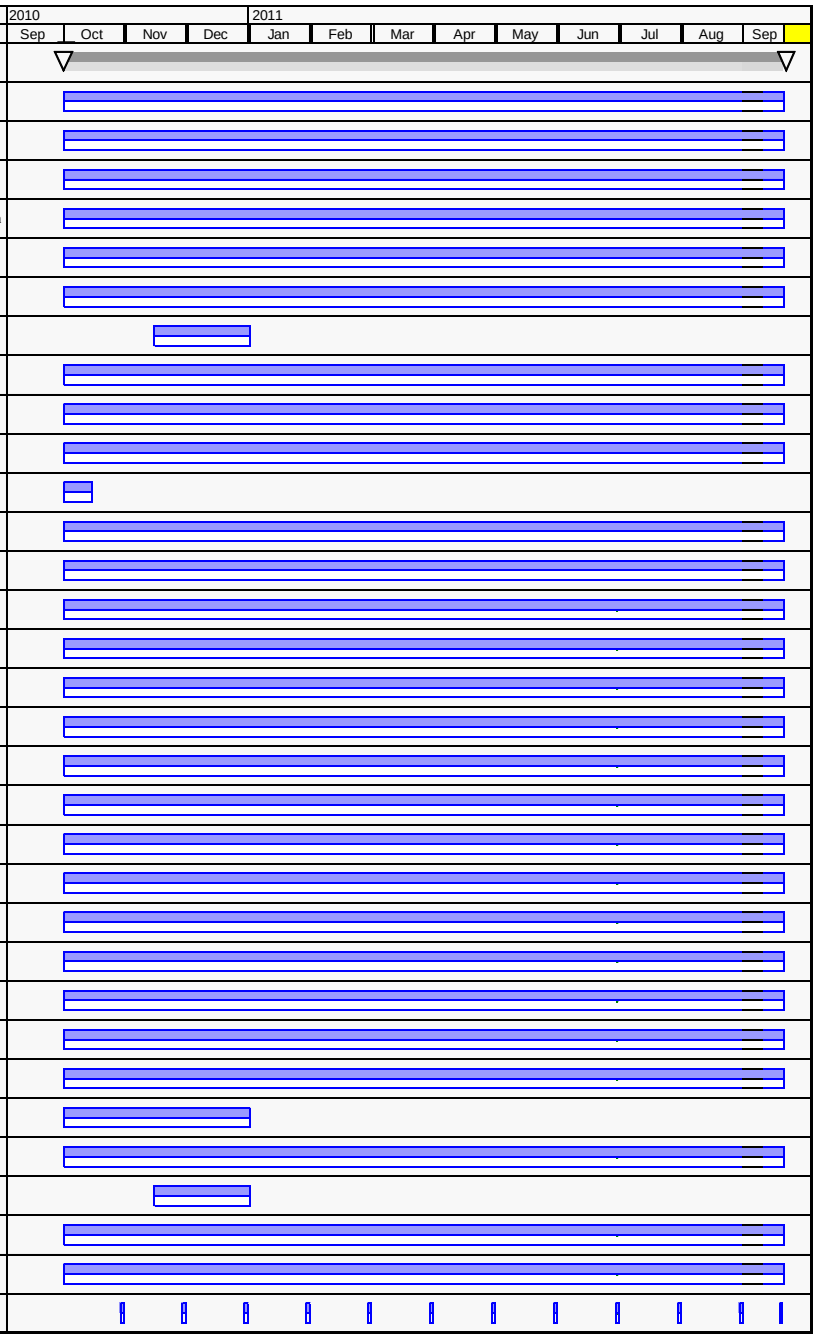
8.0 Work Shelf

The following activities could be accomplished as part of the Task Order performance by personnel that are temporarily available due to program or funding delays on other Tasks. Specific assignments will be coordinated with the Task Initiator to ensure appropriate skills and experience.

TO/Subelement	Description	Due Date	Skill

9.0 Schedule (Revision 1 update)

Task Order	s/e	Task Work Element
32-000002	00	Constellation Support to Spacecraft and Vehicle Systems
32-000002	AA	Ares V Core Stage
32-000002	AB	Ares V Vehicle Integration
32-000002	AC	Ares V 1st Stage
32-000002	AD	Aerosciences Support for Ares V Vehicle Integration
32-000002	AE	Ares V Requirements Definition
32-000002	AF	Ares V Vehicle Integration Support
32-000002	AG	Ares V Knowledge Management Support
32-000002	CA	Integrated Test and Evaluation Support
32-000002	CB	FS Structural Stress Support
32-000002	CC	FS Structural Design Support
32-000002	CD	FS Aeroscience Support
32-000002	CF	Booster Re-entry Analysis
32-000002	CG	FS System Engineering & Integration Support
32-000002	CJ	Analysis and Concept Development Support
32-000002	CL	US Structural Stress Support
32-000002	CM	US Structural Design Support
32-000002	CN	Upper Stage System Design Support
32-000002	CP	VI Structural Dynamics and Loads Support
32-000002	CR	Vehicle Structural Design Integration
32-000002	CS	VI Aeroscience Support
32-000002	CT	GN&C Flight Control Design & Analysis
32-000002	CU	GN&C and Navigation Design, Analysis and Modeling
32-000002	CV	Health Management Design & Analysis
32-000002	CW	Vehicle Systems Design Integration
32-000002	CX	VI Design Analysis and Integration
32-000002	CY	Vehicle Development and Flight Evaluation
32-000002	CZ	Knowledge Management Support
32-000002	DA	FS Structural Dynamics and Loads Support
32-000002	DB	Integrated Engineering Process Planning
32-000002	EA	LAS Risk Management
32-000002	YA	Space and Terrestrial Environments Support
32-000002	00	Monthly Activity Report



ESTS Contract Task Order Request Performance Plan

Task Order Title: Constellation Support to Spacecraft and Vehicle Systems

Task Order Number: 32-000002 Revision: 01

Category	Weighting Technical %	End of Period Technical Score
Technical Objectives	65%	X 65% =
		Justification
Execute the scope defined in Section 1 using the approach outlined in Section 2 for each subelement.		
Schedule Objectives (Milestones)	**Weighting Schedule %** 10% *(min 10%)*	**Schedule Score** X 10% =
		Justification
Provide the milestones deliverables defined in Section 6 on the schedules agreed to by EV and Jacobs.		
Cost (actual vs. negotiated)	**Weighting Cost%** 25% *(min.25%)*	**Cost Score** X 25% =
		Justification
	Weighting Total % 100.00%	**Total Score**

Technical, Schedule, and Cost Grading Scale

Score	Description
9.0-10.0	Exceeded TO Performance Plan objectives resulting in major benefit(s)
8.0-8.9	Exceeded TO Performance Plan objectives resulting in modest benefit(s)
7.0-7.9	Met TO Performance Plan objectives
3.0-6.9	Did not meet all TO Performance Plan objectives resulting in minimal impact or requiring additional agency funds
0.0-2.9	Did not meet TO Performance Plan objectives resulting in substantial impact and/or requiring additional agency funds

ESTS Contract Task Order Request Performance Plan

Task Order Number: Constellation Support to Spacecraft and Vehicle Systems

Task Order Number: 32-000002 Revision: 01

Comments:

Marshall Space Flight Center
Engineering, Science & Technical Services

JACOBS
ESTS Group

Risk Assessment

Contract Number: *NNM05AB50C*
TO Title: *Constellation Support to Spacecraft and Vehicle Systems*
TO Number: *32-000002* **Revision:** *01*

Period of Performance: *10/02/2010* to *09/30/2011*

MSFC Initiator: *Alicia Carroll (Task Initiator)*

(b)(4)

Task Order Risk Assessment to Cost, Technical, and Schedule

List identified risk associated with Task Order performance as related to task cost, technical, and schedule. Classify the risk(s) according to probability of occurrence and impact as defined below and enter the risk into risk matrix.

Risk	Risk Type	Probability (1-4)	Impact (1-4)	Risk Description
Risk C1	Cost			No Cost Risks are identified
Risk C2	Cost			
Risk T1	Technical			No Technical Risks are identified
Risk T2	Technical			
Risk S1	Schedule			No Schedule Risks are identified.
Risk S2	Schedule			

*Note: See page 2 for risk mitigation plan for those risks which are Primary Risk Drivers.

Task Order Risk Matrix

		1 Minimal Impact	2 Minor Impact	3 Medium Impact	4 Major Impact
Inevitable Occurrence (>95% Probability)	4	Y	Y	R	R
High Probability of Occurrence (>60% but <95% Probability)	3	G	Y	Y	R
Medium Probability of Occurrence (>25% but <60% Probability)	2	G	Y	Y	Y
Low Probability of Occurrence (<25% Probability)	1	G	G	Y	Y

Legend

- R — **Primary Risk Driver:** Requires Risk Mitigation Plan
- Y — **Caution:** Requires status updates and general plan for risk reduction as determined necessary by Team Lead and Initiator
- G — **Watch:** No Action required

Impact Level	Cost Impact Definition	Technical Impact Definition	Schedule Impact Definition
(1) Minimal Impact	No significant cost impact	No significant technical impact	No significant schedule impact
(2) Minor Impact	Potential to recover cost	Potential to gain required technology without impact	Minor delay in deliverables but no impact to customer
(3) Medium Impact	>0 but <10% subtask cost overrun	Some technical impact but potential to recover	Delay in subtask deliverables but work arounds available and acceptable to customer
(4) Major Impact	>10% subtask cost overrun	Unable to meet technical requirements to perform subtask	Delay in subtask deliverables with impact to customer

Risk Mitigation Plan

Complete the following chart for those risks identified on page 1 as “Primary Risk Drivers”. The following chart will serve as the Risk Mitigation Plan.

Risk No.: Risk Description:		
Mitigation Step No.	Planned Completion Date	Mitigation Step Description