Marshall Space Flight Center
Engineering, Science & Technical Services

Task Order Plan (TOP)

Contract Number: *NNM05AB50C*
TO Title: *Advanced Concepts Project Constellation Support*
TO Number: *30-000004* **Revision:** *13*

Period of Performance: 10/*2/2010* to 9/*30/2011*

MSFC Initiator: *Charles (Les) Johnson*

(b)(4)

Emergency: *No*

Subelement	WBS
30-000004-AA	206518.02.20 and 206518.08.03.20 through 10/1/2010
30-000004-AA	**206518.02.20 from Oct. 2010 to Sept. 2011**
30-000004-AB	206518.02.20 (Closed as of 10-1-10)
30-000004-CA	**136905.01.06.08 from Nov. 2010 to Sept. 2011**

Note: The bold WBS numbers are reflective of those currently in use.

Revision -13
This revision affects the following elements:
30-000004-CA

This revision does not affect the following elements:
30-000004-AA

The purpose of this revision is to:

- Add sub-element 30-000004-CA and its resulting scope and estimate:
  - Direct and subcontractor hours were added due to an increase in scope for study design and analysis activities in the areas of trajectory/performance, weights and sizing, propulsion, structures, thermal, power, avionics, configuration, mass properties, risk, and/or any other related discipline.

Revision -12
The purpose of this revision is to extend this task into Contract Year 6 of the NNM05AB50C ESTS contract. This revision defines and estimates work for the period October 2, 2010 through September 30, 2011. Additionally, the Schedule, Performance Plan and Risk Assessment have been revised to reflect changes in task activities for the new period of performance. This revision affects the following APO elements: Ares V (subelement 30-000004-AA).

Revision -11
The purpose of this revision is to:

- Update scope and resulting estimate on sub-element 30-000004-AA:
    - Direct hours were removed due to a descoping in study design activities in the disciplines trajectory analysis and weights and sizing. The analysts now have less follow-on cases to perform on the launch vehicle designs.
    - Direct hours were added due to an increase in scope for study design activities in the area of propulsion. Analyst now has an activity to research engine and propellent options.
    - (b)(4) [redacted] was added to the list of subcontractors supporting this task (see Section 5.0) to perform decision analysis and systems engineering. Hours were added to support this increase in scope.
    - Travel estimated for 1 trip to Anaheim, CA to attend and present at the Space 2010 Conference (see Section 7.0).
    - Removed Ares V specific mention from launch vehicle descriptions.
- Addition was made to risk matrix in the technical area; see line item Risk T1.
- No changes to sub-element 30-000004-AB.

Revision -10
The purpose of this revision is to:
- Change (b)(4) [redacted]
- Change [redacted]
- Adjust hours on sub-element 30-000004-AA: Scope decreased because a project coordinator is no longer required on this task and less launch vehicle analysis is needed by the customer. Additional hours were added to extend the support specific to Ares V Requirements development by (b)(4) [redacted] additional months. The net change for this sub-element was subsequently (b)(4) [redacted] hours.
- Increased hours on sub-element 30-000004-AB to keep this subelement open at a minimal effort to the end of the year for potential support.

The following sub-elements remain closed:
- 30-000004-XA
- 30-000004-CB
- 30-000004-CF
- 30-000004-CG

Revision -09
The purpose of this revision is to extend this task into Contract Year 5 of the NNM05AB50C ESTS contract. This revision defines and estimates work for the period October 3, 2009 through October 14, 2010. Additionally, the Schedule, Performance Plan and Risk Assessment have been revised to reflect changes in task activities for the new period of performance.

This revision affects the following APO elements:
Ares V: Launch Vehicle Analysis (sub-element 30-000004-AA)
Ares V: Requirements (sub-element 30-000004-AB)

The following sub-elements are closed:
- 30-000004-CB
- 30-000004-CF
- 30-000004-CG
- 30-000004-XA

Revision -08
The purpose of this revision is to:
Adjust hours on some of the sub-elements:
In particular:
30-000004-AA: Additional work was required by the customer that required an increase in man hours.
30-000004-AB: Decrease in expected workload for the remaining fiscal year.

The following sub-element did not change:

- 30-000004-XA

The following sub-elements remain closed:

- 30-000004-CB
- 30-000004-CF
- 30-000004-CG

Revision -07
The purpose of this revision is to:

1. Split sub-element 30-000004-XA into two sub-elements 30-000004-XA and 30-000004-AB in order to reflect past (subelement XA) and future support (subelement AB) to the Ares V project office. As a result sub-element 30-000004-XA will be closed as of May 31st as it received the wrong sub-element assignment and subelement AB, which reflects the correct subelement lettering assignment, will be opened. (Note that the past charges against sub-element XA are funded under WBS 206518.02.20 and as of June 1st, only sub-element 30-000004-AB will be used.)
2. Due to a decrease in the scope of work, reduce the total estimate of the work under WBS 206518.02.20 from (b)(4) [redacted] to approximately (b)(4) [redacted] The total estimate was reduced by (b)(4) [redacted] and is split between sub-elements XA and AB.

The following sub-element did not change:

- 30-000004-AA

The following sub-elements remain closed:

- 30-000004-CB
- 30-000004-CF
- 30-000004-CG

Revision -06
The purpose of this revision is to:

- Change 30-000004-AA's WBS number from 206518.02.10 to 206518.02.20
- Add new sub-element 30-000004-XA and the associated hours to complete those task activities

This revision affects the following APO elements:

- Sub-element 30-000004-AA
- Sub-element 30-000004-XA

The following sub-elements remain closed:

- 30-000004-CB
- 30-000004-CF
- 30-000004-CG

Revision -05

The purpose of this revision is to:
Change the MSFC Initiator from Jack Mulqueen to Les Johnson
Add another subcontractor's support to sub-element 30-000004-AA
Scale hours back to reflect a typical employee's man hours (approximately [redacted] (b)(4) [redacted]
Update the FY09 WBS number which corresponds to sub-element 30-000004-AA

This revision affects the following APO elements:

- Ares V: sub-element 30-000004-AA

The following sub-elements remain closed:

- 30-000004-CB
- 30-000004-CF
- 30-000004-CG

Revision -04
The purpose of this revision is to extend this task into Contract Year 4 of the NNM05AB50C ESTS contract. This revision defines and estimates work for the period September 27, 2008 through October 2, 2009. Additionally, the Schedule, Performance Plan and Risk Assessment have been revised to reflect changes in task activities for the new period of performance. This revision assumes full funding for all staff currently in place on this task.

This revision affects the following APO elements:

- Ares V or the cargo launch vehicle, CaLV (sub-element 30-000004-AA)

The following sub-elements are currently closed:

- 30-000004-CB
- 30-000004-CF
- 30-000004-CG

Revision -03
This purpose of this revision is to:

- Adjust the sub-elements as necessary. In particular:
  - 30-000004-AA: Increase in the hourly estimate by (b)(4) hours. No additional budget is required.
  - 30-000004-CB: No changes were made (No funding currently on this sub-element)
  - 30-000004-CF: No changes were made, and no additional budget is required.
  - 30-000004-CG: No changes were made (No funding currently on this sub-element)
- Change the roles and responsibilties of the (b)(4) [redacted]

Revision -02
This revision is to re-distribute hours among the tasks because some sub-elements did not receive speculated funding and other sub-elements increased in work load. In particular:
30-000004-AA: Decrease in dollars because new employee's ES level was lower that we estiamted and decrease in hours because he did not come on board as quickly as we thought he would so hours were removed.
30-000004-CB: No change
30-000004-CF: Hours were re-distributed to reflect study schedule and dollars were added to finalize study.
30-000004-CG: No change

Revision -01
This revision is to: update new team and task leads, add a new (b)(4) [redacted] to sub-element -AA, update project coordinator skill set, reduce hours on –CF to 25% the rest of the year, and eliminate hours for –CG after March.

1.0 Task Order Description & Objectives

This Task Order has been implemented due to a NASA MSFC reorganization. This Task Order was previously under Task Order 31-060303.

The objective of this Task Order is to provide engineering support to the MSFC Advanced Concepts Office (ED04) design, analysis, project management and systems engineering tasks. This work will include support to develop conceptual and preliminary engineering design configurations for feasibility studies of advanced space launch vehicles and payload systems and their supporting equipment. Design configurations will focus primarily on areas such as but not limited to launch vehicle design, vehicle interfacing requirements, mission analysis, vehicle operations; vehicle sub-components such as tankage, thrust structure, engine and engine placement, propulsion systems, payload accommodations, electrical cabling and fluid piping, thermal management, power and avionics, and electronic equipment packaging and placement. In addition to supporting in-office studies, the task objective also includes doing reviews, providing technical advice, and coordinating related work performed by other engineers within MSFC and industry. The objective of this task addition is also to support analytical studies for development of conceptual and preliminary engineering design configurations for advanced in-space vehicle concepts employing advanced physics and engineering principles. This Task Order will provide support for developing conceptual design computer tools, in addition to producing animations. This Task Order will also provide support for project planning, coordination, integration, review and reporting as well as engineering coordination activities in direct support of MSFC Advanced Concepts (ED04). Furthermore, data management and requirements support may be required.

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

Task Order personnel will provide support for the Advanced Concepts Office (ED04) for development of conceptual and preliminary engineering design configurations for feasibility studies of advanced space launch vehicles and payload systems and their supporting equipment. Where specialized skills and experience are required, subcontractor support will be sought to provide the best capability and efficiency to the NASA customer.

2.1 <u>Conceptual and Preliminary Engineering Design</u>

Conceptual and preliminary engineering design configurations of space vehicles in general will be developed using input from the (b)(4) or from concepts developed during project team meetings and other information sources. Other sources of information include but are not limited to, research of existing literature and past space vehicles documentation and information obtained from NASA and contractors team members specialized in the various systems and subsystems disciplines who are involved in the development of a particular vehicle design. Design configurations will be generated using Pro-Engineer and/or Uni-graphics CAD software tools or any other tool specified by the NASA customer to create solid models from which CAD drawings, and graphical illustrations can be generated. Illustrations will be transposed to Microsoft programs such as PowerPoint to make graphical representations for integration in final documentation packages or for presentations to ED04 customers and animations depicting the designs may be required.

Supporting analytical studies include support for system performance analysis of aerospace systems including such discipline areas as, but not limited to, trajectory, propulsion, mass properties, structures, power management and distribution, thermal protection, environment and life support systems (ECLSS), active and passive thermal control, fluid flow analysis, operations, extra-vehicular activity (EVA) systems, crew habitat sizing, avionics, and landing systems. Activities could include identifying and researching the required existing and advanced technologies in the various engineering disciplines utilizing existing codes, or developing new or modifying codes to create enhancements to support quick vehicle design conceptual studies and more extensive studies.

2.2 <u>Launch Vehicle Definition and Analysis</u>:

Support will be provided for vehicle performance and trajectory analysis related to launch and in-space vehicle studies lead by ED04. The Program to Optimize Simulated Trajectories (POST), Optimal Trajectories by Implicit Simulation (OTIS) and Optimum Guidance (OPGUID) computational models will be utilized, as required, for all trajectory analysis performed in support of vehicle studies. The industry standard in-space trajectory, performance and sizing tools will be used, as necessary.

2.3 Systems Engineering and Project Management Support:

Systems Engineering and Project Management Support will be provided to the MSFC Advanced Concepts Office (ED04) for concepts development of future space vehicles. Engineers will be assisted in the development of study plans, requirements and data management, support ongoing risk and technology assessment efforts, and perform analyses as needed. Assistance in the development of necessary tools for the analysis and design of future space vehicle concepts will be provided. Cost and schedule support may also be required.

2.4 Task Order Sub-Elements:

Sub-element –AA
Concept Trade Studies and Launch Vehicle Performance Support
Contractors will provide support for concept trade studies for the launch vehicles. They will perform analysis in the following areas: trajectory/performance, weights and sizing, and such disciplines as: propulsion, structures, thermal, power, avionics, configuration and mass properties. This work will be for the launch vehicles and other in-space stages for Advanced Concepts in support of transportation architecture studies. This sub-element could also provide support for requirements work, decision analysis, system engineering and integration analyses, data management, project planning, coordination, integration, animation, review and reporting as well as engineering coordination activities in direct support of MSFC Advanced Concepts (ED04).

Sub-element –CA
Launch Vehicle Systems Advanced Concepts
This subelement will support the investigation of launch vehicle options including but not limited to: heavy lift launch vehicles, upper stages, and related space systems. Support includes the performance of analyses in the following disciplines: trajectory/performance, weights and sizing, propulsion, structures, thermal, power, avionics, configuration, mass properties, risk, and/or any other related discipline. This subelement also provides support for transportation architecture studies, requirements work, literature reviews, decision analysis, system engineering and integration analyses, data management, animations, project planning, project coordination, integration, review and reporting, and technical publications.

Sub-element –AB (CLOSED as of 10-2-2010)
Payload Concept Design, Analysis, and Requirements Tasks
The objective of this sub-element is to provide support to the MSFC Advanced Concepts Office (ED04) payload concept design, analysis, and requirements tasks.

Sub-element –XA (CLOSED as of the release of revision 7) (Sub-element was removed and renamed as subelement AB – Ares V Payload Concept Design, Analysis, and Requirements Tasks to reflect support to and funding from the Ares V project office)
Constellation Concept Design and Analysis Tasks
The objective of this sub-element is to provide engineering support to the MSFC Advanced Concepts Office (ED04) Ares-V concept design and analysis tasks.

Sub-element –CB (CLOSED as of 4-15-2008)
Project Constellation LIDS Docking Interface Loads Analysis

The contractor will perform concept design of Ares V earth departure stage concepts and evaluate the structural loads on the Low Impact Docking System (LIDS) during mission propulsive maneuvers.

Sub-element –CF (CLOSED as of 7-20-2008)
CLV (Ares I) Upper Stage System Trades and Analysis Support
Contractors will provide support for concept trade studies for the CLV upper stage, performing trajectory/performance and sizing in support of the Exploration Launch Office.

Sub-element –CG (CLOSED as of 4-1-2008)
Project Constellation Integrated Performance Analysis (Cx IPA)
Contractors will perform analysis of integrated space exploration transportation architectures for human lunar and Mars missions.

3.0 Discussion of Skills Required

(b)(4)

[redacted]

(b)(4)

[redacted]

Technical skill requirements for the vehicle design and configuration portion of the Task Order require engineers with knowledge in advanced space launch vehicle design and integration, airframe and structural design and analysis, mechanical and mechanisms design, vehicle configuration, mass properties and subsystems interfaces. Additional skill requirements include importing/exporting and conversion of model files to and from other codes. Engineers should also be skilled in interfacing with other disciplines to get definition inputs to ensure requirements are fulfilled (stress, dynamics, aerodynamics, performance, mass properties, thermal, propulsion and power, avionics, Guidance, Navigation and Control (GN&C) and Configuration and Data Handling (C&DH).

4.0 Special Tools Required

Tools to perform trajectory analysis and weights and sizing for the launch vehicles include Program to Optimize Simulated Trajectories (POST) and INTegrated ROcket Sizing (INTROS).
Preliminary thermal and structural analysis of vehicles and spacecraft will be performed as required using Computer Aided Engineering (CAE) codes such as Patran/Nastran, FEMAP, Hypersizer, and Thermal Desktop. Design and configuration models will be generated by Pro-Engineer. Additional training may be required in any tool to stay current as these codes keep evolving. Other tools may include any number of power/avionics/GN&C tool, COPA for mission analysis, and animation tools, such as but not limited to 3D Studio Max. Analytical studies may require codes such as FORTRAN and C, C++ and other codes as required. MSFC will provide all computers and required software.

5.0 Participating Subcontractors

(b)(4)

[redacted]

6.0 Milestones & Deliverables

- CAD solid models and/or two-dimensional layouts of vehicle design configuration(s) with engineering assessments, vehicle mass properties and graphical illustrations
- Analytical and programming tools, technical manuals, technical reports & assessments as a result of doing vehicle conceptual design analytical studies and propulsion performance studies.
- Monthly analysis assessments (including tools, trades, analysis planning) as performed.
- Trajectory analysis tool development and calculations.
- Newly developed Mass Estimating Relationships (MERs) and associated documentation.
- Newly developed Mass Estimating models or algorithms.
- Documentation for any mass estimating capability developed during the period of performance.
- Discrete vehicle performance estimates.
- Baseline set of vehicle trajectories for rocket based and air breathing references.
- Newly developed Performance Analysis and Tools capability complete with documentation.

- Meeting notes and review comments as requested, and reports on independent analysis in the form of briefing charts and notes-page text. The subcontractor shall submit brief monthly reports (Monthly Activity Reports) summarizing activities for the reporting period for each calendar month of work due by the 19th of the current month to the Technical Point of Contact (Task Order – (b)(4)
- A summary set of presentation charts in Power Point-style documenting conceptual drawings/sketches, trajectory/mission design, payload performance, mass estimates, concept dimensions, and supporting cost/operations/economics/safety estimates (as appropriate for the study). The level of detail presented in the documentation will be consistent with the level of detail of the individual study being documented. The subcontractor will provide monthly status reports (progress reports) to documenting any studies completed during the month and the status of any on-going studies. The subcontractor shall provide technical data and graphics (tables, plots, CAD pictures) pertaining to concepts studied that can be used in the development of technical papers and other archival documentation (AIAA papers, NASA TP/TM publications, journal articles), as requested by the customer.

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

This Task Order requires for personnel to be located at an on-site building designated by MSFC Task Initiator. MSFC Advanced Concepts Branch (ED04) will provide computing hardware and software to carry the duties of the Task Order and the employee shall follow MSFC material control requirements.

Travel:
The travel estimate includes the resources for the following:

- 30-000004-AA: 2 trips are estimated. Location (and purpose) are currently TBD.

ODC:
The ODC estimate includes the resources for the following:

- 30-000004-AA: 2 conference fees are estimated. Location (and purpose) are currently TBD.

Personnel assigned to the Task Order shall also conform to MSFC safety regulations and work guidelines.

Technical support for the various ED04 studies will be prioritized accordingly on an equal split basis. In the event that a particular study has priority over another, the Task Initiator will be consulted to add resources, complete the work or authorize a different workload distribution.

Task Order personnel so designated as Foreign National status will be required to meet certain security requirements (escort requirement after office hours, restricted access to ITAR materials). Additional cost associated with corporate sponsorship of personnel VISA maintenance and application for permanent residency status may apply.

Task Order personnel reviewing classified material shall have the appropriate clearance to re-view such material.

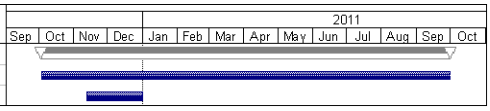
8.0 Work Shelf

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

Task Order #	Subelement	Task Work Element
30-000004	**00**	**Advanced Concepts Project Constellation Support**
30-000004	AA	Concept Trade Studies and Launch Vehicle Performance Support
30-000004	CA	Launch Vehicle Systems Advanced Concepts



ESTS Contract Task Order Request Performance Plan

Task Order Title: Advanced Concepts Project Constellation Support

Task Order Number: 30-000004 Revision: 13

Category	Weighting Technical %	End of Period Technical Score
Technical Objectives	65%	X 65% =
		Justification
Design configurations and analytical studies will be developed using input from project lead and from other sources of information. Other sources of information include but are not limited to, research of existing literature and studies of space vehicles that have flown and primarily, information obtained from working in cooperation with NASA team members specializing in the various subsystems involved to develop a particular design. Graphics of design configurations are to be generated using Pro/E CAD software code or any other code specified. The specified software will be used to produce solid engineering models. Applicable CAD views will be transposed to Microsoft programs such as Powerpoint and Word.		
Schedule Objectives (Milestones)	**Weighting Schedule %** 10% *(min 10%)*	**Schedule Score** X 10% =
		Justification
1. Support independent conceptual studies as required. Provide all necessary output deliverables (in the form of CAD solid models, drawings, concepts, graphical charts, technical/analysis reports, etc.) within the time frame specified by the study lead at the start of each study. Subtask schedule slips due to uncontrollable circumstances such as time required for external reviews, failure to receive requirements, reprioritization of studies will not be factored negatively in assessing schedule objectives. 2. Participate in reviews, technical conferences, provide technical advice, and		

ESTS Contract Task Order Request Performance Plan

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coordinate related work performed by other engineers as required.		
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: Advanced Concepts Project Constellation Support

Task Order Number: 30-000004 Revision: 13

Comments:

Marshall Space Flight Center
Engineering, Science & Technical Services

JACOBS
ESTS Group

Risk Assessment

Contract Number: *NNM05AB50C*
TO Title: *Advanced Concepts Project Constellation Support*
TO Number: *30-000004* **Revision:** *13*

Period of Performance: 10/*2/2010* to 9/*30/2011*

MSFC Initiator: *Charles (Les) Johnson*

(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 have been identified for this Task Order.**
Risk C2	Cost			
Risk T1	Technical	2	3	**Personnel changes could result in a decrease in efficiency.**
Risk T2	Technical			
Risk S1	Schedule	2	2	**Delays in required inputs for analyses could result in late delivery.**
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