

Contract Number: NNM05AB50C
TO Title: Modeling&Simulation-Digital Manufacturing
TO Number: 34-040002 **Revision:** 15

Period of Performance: 10/02/2010 to 03/31/2011

MSFC Initiator: Steven Phillips

(b)(4)



Emergency: No

REVISION 15:

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 March 31, 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 closes Subelement - 01 and adds a new subelement to the task (Subelement – ST).

Subelement – ST – Shuttle External Tank

WBS# 524238

This revision adds to the task to provide support of the Shuttle program.

Per the customer's request, this revision also changes the MFSC initiator from Majid Babai to Steven Phillips.

REVISION 14:

The purpose of this revision is to add scope and funds to subelement - 01 to investigate alternative and advanced process planning and work instruction development and delivery methods for increased shuttle processing efficiency and paperless archival of as-built data. Additionally, archival of shuttle related paper documents into a digital format and assistance in the transfer of servers/databases from MAF to MSFC for long-term archival of engineering related data will be performed under subelement 01. And lastly, additional funds were added to subelement – 01 per the request of the NASA customer for travel to support testing of specialized equipment.

Subelements CA, CC, CO, CW and DF have been administratively closed in an activity separate from this revision to reflect changes in scope for Ares work. The work corresponding to these subelements covered by this task is being continued under the new task order 34-000001 subelement CG. The schedule has been revised to reflect the closed subelements and the costs for the Ares subelements have been updated administratively.

REVISION 13:

This is a customer requested revision that updates descriptions for Subelement – 01 and Subelement CA and adds a new subelement to the task (Subelement – DF). Estimate for travel and training will be

added to Subelement – DF. The Performance Plan and Risk Assessment have not been revised since they are not affected.

(b)(4)

Subelement – 01 – Shuttle

Updated Task Order Description & Objectives section to include: Provide support to the advancement of the rapid prototyping technologies and the lab to better assist the program.

Subelement – CA – CLV Integrated Manufacturing and Assembly

WBS# 136905.08.05.12.01.08

Updated Task Order Description & Objectives section to include: Provide support to the advancement of the rapid prototyping technologies and the lab to better assist the program.

Subelement – DF – Upper Stage Integrated Avionics

WBS# 136905.08.05.08.01.08

This revision adds to the task to provide travel and ODC estimate to provide training in support of the Ares/Constellation program.

REVISION 12:

This is a customer requested revision and removes subcontractor estimate from Subelement -CA for metrology and as-built modeling services and adds a new subelement to the task (Subelement -CO). Subcontractor estimate for metrology and as-built modeling services will be added to Subelement -CO. The Performance Plan and Risk Assessment have not been revised since they are not affected.

Subelement – CA – CLV Integrated Manufacturing and Assembly

WBS# 136905.08.05.12.01.08

This revision removes (b)(4) in subcontractor estimate to the task to provide metrology and as-built modeling services in support of the Ares/Constellation program.

Subelement – CO – Upper Stage Structural Development Test Article

WBS# 136905.08.05.12.03.08

This revision adds (b)(4) in subcontractor estimate to the task to provide metrology and as-built modeling services in support of the Ares/Constellation program.

REVISION 11:

This revision adds scope to subelement CA to provide metrology and as-built modeling services required by the customer and adds subcontractor estimate to subelement CA to provide this support. (b)(4) and corrects the estimate for other subcontractor support for subelement CA. The Performance Plan was revised to reflect the new scope being added to the task, but the Risk Assessment has not been revised since it was not affected. The total task order estimate increased from (b)(4)

Subelement – CA – CLV Integrated Manufacturing and Assembly

WBS# 136905.08.05.12.01.08

This revision adds (b)(4) in subcontractor estimate to the task to provide metrology and as-built modeling services in support of the Ares/Constellation program.

This revision also increases the (b)(4) subcontractor labor estimate by (b)(4) to more accurately reflect the effort required during this period of performance.

REVISION 10:

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 Ares I Upper Stage APO elements:

- Upper Stage (subelement CA)
- Upper Stage (subelement CC)
- Upper Stage (subelement CW)

REVISION 09:

The purpose of this revision is to more accurately reflect the effort required during this period of performance. The total task order estimate increased from (b)(4) (b)(4) The Performance Plan and Risk Assessment have not been revised since they are not affected.

(b)(4)

Subelement – 01 – Shuttle

This revision increases the labor estimate by (b)(4) to more accurately reflect the effort required during this period of performance.

Subelement – CA – CLV Integrated Manufacturing and Assembly

WBS# 136905.08.05.12.01.08

This revision increases the labor estimate by (b)(4) to more accurately reflect the effort required during this period of performance.

Subelement – CB – CLV LOX and LH2 Tank and Structural Test Articles

WBS# 136905.08.05.12.02.08

This revision reduces the labor estimate by (b)(4) to more accurately reflect the effort required during this period of performance.

REVISION 08:

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 affects the Ares I Upper Stage APO element (subelements CA & CB).

REVISION 07:

The purpose of this revision is to more accurately reflect the effort required during this period of performance. The total task order estimate decreased from (b)(4) a reduction of (b)(4) The Performance Plan and Risk Assessment have not been revised since they are not impacted by the changes reflected in this revision.

(b)(4)

Subelement – 01 – Shuttle (Revised)

Labor:

This revision reduces the labor estimate by (b)(4) to more accurately reflect the effort required during this period of performance.

Subelement – 02 – SLS Machine Upgraded (Revised)

Material:

This revision increases the materials estimate by (b)(4) to more accurately reflect the cost of the SLS machine upgrades.

Subelement – CA – CLV Integrated Manufacturing and Assembly (Revised)

WBS# 136905.08.05.12.01.08

Labor:

This revision reduces the labor estimate by (b)(4) hours (b)(4) to more accurately reflect the effort required during this period of performance.

Subcontract:

This revision reduces the subcontracting estimate by (b)(4) to more accurately reflect the effort required during this period of performance.

Subelement – CB – CLV LOX and LH2 Tank and Structural Test Articles (Revised)

WBS# 136905.08.05.12.02.08

Labor:

This revision reduces the labor estimate by (b) hours (b)(4) to more accurately reflect the effort required during this period of performance.

Revision 06 is being written to correct the accidental removal of estimated labor hours for (b)(4) (b)(4) in Revision 05. The hours have been reinserted. In addition to this, materials estimate has been added with a new subelement -02 that will repair and upgrade the selective laser sintering machine (SLS) in the rapid prototyping lab. A (b)(4) has been identified, and should start in mid-January 2008. Identified that subelement –CB is unnecessary and the estimate has been moved to subelement –CA and –CB has been closed.

Revision 05 is being written to extend this task into Contract Year 3 of the NNM05AB50C ESTS contract. This revision defines and estimates work for the period 29 September 2007 through 26 September 2008. Additionally, the Schedule, Performance Plan, and Risk Assessment have been revised to reflect changes in task activities for the new period of performance. (b)(4) is being transferred to (b)(4) and (b)(4) is being reassigned to support activities associated with the rapid-prototyping laboratory. The vacated (b)(4) (b)(4) Recruitment of this person may require additional direct costs, which have been reflected in the estimate. A nominal amount has been inserted in anticipation of travel needs of task members.

Revision 04 moves some of the current estimate for rapid prototyping and tool crib support from subelement-01 to subelements –CA, and –CB to support Ares I upperstage work. This revision also adds subelement –CB for CLV LOX and LH2 tank and structural test article support.

This revision (03) changes the labor category (b)(4) and start work dates for the newly hired personnel. Also added new subelement for rapid prototyping and tool crib support (Subelement-01), added (b)(4) to this task order that was previously providing rapid prototyping support on task order 34-010003, added a (b)(4) and added travel for a trip to KSC. The other task documents were revised as required to reflect these changes.

Revision 02 changed the labor categories from (b)(4) and reduces the labor hours to reflect more representative start work dates. Additional relocation estimate was added to cover known and anticipated expenses. The other task documents did not require revision. This work is funded through PR 4200173425.

The purpose of this revision (01) is to extend this task into Contract Year 2 of the NNM05AB50C ESTS contract. This revision defines and estimates work for the period 30 September 2006 through 28 September 2007. Subelement 01 has been changed to Subelement CA. Additionally, the Schedule, Performance Plan and Risk Assessment have been revised to reflect changes in task activities for the new period of performance. This work is funded through PR 4200173425.

1.0 Task Order Description & Objectives

(b)(4)



Subelement-02, SLS Machine Upgrade (Closed)

Determine needs and coordinate repairs on the selective laser sintering machine.

Subelement-CA, Ares I Integration and Manufacturing (WBS No. 136905.08.05.12.01.08) (Closed)

(b)(4)



Computer-Aided Design (CAD) models of the pertinent manufacturing areas, processing equipment, and the CLV Upper Stage at various states of assembly will be produced. The models will be created or imported from other sources using the DELMIA software suite to create a digital mockup of the manufacturing process, perform geometrical interference checks, and support the validation of manufacturing plans and processes.

This subelement will also include providing assistance in assignments related to manufacturing engineering, human factors simulations for specific assembly challenges, and editing/converting simulations to common video format.

(b)(4)



Subelement-CB, Ares I LOX and LH2 Tanks and Structural Test Articles (WBS No. 136905.08.05.12.02.08) (Closed)

Provide engineering and technician support for the MSFC Building 4707 rapid prototyping facility and tool cribs in Buildings 4707 and 4711 for CLV LOX and LH2 tank and structural test article support.

Provide engineering and technician support for the MSFC Building 4707 Materials, Processes, and Manufacturing Department tours.

Subelement-CC, Cryogenic Insulation (WBS No. 136905.08.05.12.07.08) (Closed)

Support will be provided to the Materials and Processes Laboratory Nonmetals Engineering Branch for the Crew Launch Vehicle (CLV) Upper Stage cryogenic insulation manufacturing process development. Primarily, this includes the creation of a digital mockup of the related MSFC facility work areas and the use of digital manufacturing and assembly simulations to facilitate the design and provide validation of manufacturing processes.

Computer-aided design (CAD) models of the pertinent manufacturing areas, processing equipment, and the CLV Upper Stage at various states of assembly will be produced. The models will be created or imported from other sources using the DELMIA software suite to create a digital mockup of the manufacturing process, perform geometrical interference checks, and support the validation of manufacturing plans and processes.

This subelement will also include providing assistance in assignments related to manufacturing engineering, human factors simulations for specific assembly challenges, robotic simulations that will be downloaded to the facility robot, and editing/converting simulations to common video format.

Provide engineering and technician support for MSFC Building 4765 and 4739.

Subelement-CO, Upper Stage Structural Development Test Article (WBS No. 136905.08.05.12.03.08) (Closed)

(b)(4)



Computer-Aided Design (CAD) models of the pertinent manufacturing areas, processing equipment, and the CLV Upper Stage at various states of assembly will be produced. Creation of digital mockups of the manufacturing process, perform geometrical interference checks, and support the validation of manufacturing plans and processes.

Subelement-CW, Common Bulkhead Manufacturing Demonstration Article (WBS No. 136905.08.05.12.02.08.11) (Closed)

Support will be provided to the Materials and Processes Laboratory Nonmetals Engineering Branch for the Crew Launch Vehicle (CLV) Upper Stage cryogenic insulation manufacturing process development. Primarily, this includes the creation of a digital mockup of the related MSFC facility work areas and the use of digital manufacturing and assembly simulations to facilitate the design and provide validation of manufacturing processes.

Computer-aided design (CAD) models of the pertinent manufacturing areas, processing equipment, and the CLV Upper Stage at various states of assembly will be produced. The models will be created or imported from other sources using the DELMIA software suite to create a digital mockup of the manufacturing process, perform geometrical interference checks, and support the validation of manufacturing plans and processes.

This subelement will also include providing assistance in assignments related to manufacturing engineering, human factors simulations for specific assembly challenges, and editing/converting simulations to common video format.

Provide engineering and technician support for MSFC Buildings 4705, 4707, 4708, 4752, and 4755.

Subelement – DF – Upper Stage Integrated Avionics (WBS# 136905.08.05.08.01.08) (Closed)

This subelement will provide travel and training in support of the Ares/Constellation program. This training will include advancing the technology competency levels and keeping the personnel current.

Subelement - ST, Shuttle External Tank

(b)(4)

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

Subelement-01, Shuttle (Closed)

- a. Support EM40 personnel in definition of rapid prototyping processing requirements (material, deposition rates, environment, etc.)
- b. Operate and maintain rapid prototyping equipment.
- c. Serve as interface with facilities management and maintenance personnel.
- d. Perform review and quality check of data.
- e. Document results per customer requirements.
- f. Data collection via laser tracker, photogrammetry, and non-contact scanning. All required equipment is currently owned by NASA.
- g. Analysis of as-built data to include inspection reports, comparison of actual to nominal definitions Computer Aided Design (CAD), and dimensional analysis.
- h. As-Built Model construction using scanned data to define actual component geometry within the CAD environment. Software to be employed will be Geomagic Studio and Pro/Engineer, both owned by NASA.
- i. Majority of work will be performed at MSFC but will on occasion require limited activity at MAF and potentially other NASA or suppliers locations.
- j. Development of robotic programs in an off-line environment utilizing software such as DELMIA or through teach pendant programming.

Subelement-02, SLS Machine Upgrade (Closed)

- a. Determine needs and coordinate repairs on the selective laser sintering machine. This will be procured effort.

Subelement-CA, Ares I Integration and Manufacturing (Closed)

- a. Use the DELMIA software suite to import existing or create new three dimensional digital mockups of the related MSFC and MAF work areas and processing equipment. A digital mockup of the CLV Upper Stage and its' various parts will be imported from engineering design CAD models as they become available. The manufacturing process will be simulated as the CLV Upper Stage progresses from individual parts to the completed, final assembly. Travel to MAF will be required to obtain information relative to that facility.
- b. Create simulations that show the CLV Upper Stage progressing through all manufacturing steps and moving from station to station. Geometrical interference checks will be performed using the models and simulations.
- c. Use digital mockups to support validation of CLV Upper Stage manufacturing plans and processes. The manufacturing process flow will be optimized for overall efficiency and the safety of personnel and hardware.

Subelement-CB, Ares I LOX and LH2 Tanks and Structural Test Articles (Closed)

- a. Support EM40 personnel in definition of rapid prototyping processing requirements (material, deposition rates, environment, etc.)
- b. Operate and maintain rapid prototyping equipment.
- c. Staff tool cribs in MSFC Buildings 4707 and 4711 on a part-time basis. Inspect and stock incoming supplies, distribute tools and consumables to users according to established procedures.

d. Support EM40 Materials, Processes, and Manufacturing Department tours. This covers the CAD/CAM and Rapid Prototyping labs.

Subelement-CC, Cryogenic Insulation (Closed)

- a. Use the DELMIA software suite to import existing or create new three dimensional digital mockups of the related MSFC work areas and processing equipment. A digital mockup of the CLV Upper Stage and its' various parts will be imported from engineering design CAD models as they become available. The manufacturing process will be simulated as the CLV Upper Stage progresses from individual parts to the completed, final assembly. Travel to MAF will be required to obtain information relative to that facility.
- b. Create simulations that show the CLV Upper Stage progressing through the cryogenic insulation manufacturing process, interference checks will be performed using the models and simulations.
- c. Use digital mockups to support validation of CLV Upper Stage manufacturing plans and processes. The manufacturing process flow will be optimized for overall efficiency and the safety of personnel and hardware.
- d. Perform human factors simulations to determine if challenging manufacturing steps for CLV Upper Stage can be completed by assembly/process personnel.
- e. Edit and convert CLV Upper Stage digital simulations to create video clips in a commonly available video format. These video clips will be for use by personnel outside of the modeling and simulation environment for various purposes.
- f. Generate off-line programs based on the digital simulations and upload to the facility robot that will be used for cryogenic insulation applications.

Subelement-CO, Upper Stage Structural Development Test Article (Closed)

- a. Data Collection via Laser Tracker, Photogrammetry, and non-contact scanning. All required equipment is currently owned by NASA.
- b. Analysis of as-built data to include inspection reports, comparison of actual to nominal definitions Computer Aided Design (CAD), and dimensional analysis.
- c. As-Built Model construction using scanned data to define actual component geometry within the CAD environment. Software to be employed will be Geomagic Studio and Pro/Engineer, both owned by NASA.
- d. Majority of work will be performed at MSFC but will on occasion require limited activity at MAF and potentially other NASA or suppliers locations.

Subelement-CW, Common Bulkhead Manufacturing Demonstration Article (Closed)

- a. Use the DELMIA software suite to import existing or create new three dimensional digital mockups of the related MSFC work areas and processing equipment. A digital mockup of the CLV Upper Stage and its' various parts will be imported from engineering design CAD models as they become available. The manufacturing process will be simulated as the CLV Upper Stage progresses from individual parts to the completed, final assembly. Travel to MAF will be required to obtain information relative to that facility.
- b. Create simulations that show the CLV Upper Stage progressing through all manufacturing steps and moving from station to station. Geometrical interference checks will be performed using the models and simulations.
- c. Use digital mockups to support validation of CLV Upper Stage manufacturing plans and processes. The manufacturing process flow will be optimized for overall efficiency and the safety of personnel and hardware.

Subelement – DF – Upper Stage Integrated Avionics (Closed)

- a. Receive robotics programming training for setups, functionality, operations, and simulations.
- b. Attend technical conferences to enhance technological knowhow and to stay current with technology advancement.

Subelement - ST, External Tank Shuttle

- a. Support EM40 personnel in definition of rapid prototyping processing requirements (material, deposition rates, environment, etc.)

- b. Operate and maintain rapid prototyping equipment.
- c. Serve as interface with facilities management and maintenance personnel.
- c. Perform review and quality check of data.
- d. Document results per customer requirements.

3.0 Discussion of Skills Required

Subelement-01, Shuttle (Closed)

(b)(4)



Subelement-02, SLS Machine Upgrade(Closed)

Repairs and upgrades will require a thorough understanding of the operations and upkeep of the SLS machine and of the capabilities of the device with upgrades.

Subelement-CA, Ares I Integration and Manufacturing (Closed)

(b)(4)



Subelement-CB, Ares I LOX and LH2 Tanks and Structural Test Articles (Closed)

(b)(4)



(b)(4)



(b)(4)



(b)(4)

Subelement – DF – Upper Stage Integrated Avionics (Closed)

Training and conference will provide advanced technical skills.

Subelement-ST, Shuttle External Tank

(b)(4)

4.0 Special Tools Required

SE2 computer seat with additional memory or better.

Pro Engineer design engineering software suite.

Video capturing software.

5.0 Participating Subcontractors

(b)(4) – Provide task labor support under Subelement -ST for rapid prototype processing.

6.0 Milestones & Deliverables

Deliverables will include: Monthly activity reports; input to biweekly notes via e-mail; CAD files; manufacturing simulations and reports documenting results in accordance with project requirements.

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

No special considerations required.

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
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9.0 Schedule

Task Order #	Subelement	Task Work Element							
			Oct	Nov	Dec	Jan	Feb	Mar	
34-040002	00	Modeling & Simulation - Digital Manufacturing							
34-040002	ST	Shuttle External Tank							

ESTS Contract Task Order Request Performance Plan

Task Order Title: [Modeling&Simulation-Digital Manufacturing](#)

Task Order Number: [34-040002](#) Revision: 15

Category	Weighting Technical %	End of Period Technical Score
Technical Objectives	65%	X 65% = Justification
Provide metrology and as-built rapid prototype modeling services in support of the Space Shuttle External Tank program.		
Schedule Objectives (Milestones)	Weighting Schedule % 10% (min 10%)	Schedule Score X 10% = Justification
Submission of Monthly activity reports; Submission of input to biweekly notes; Reports documenting results in accordance with project requirements.		
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: [Modeling&Simulation-Digital Manufacturing](#)

Task Order Number: [34-040002](#) Revision: [15](#)

Comments:

Risk Assessment

Contract Number: NNM05AB50C
TO Title: Modeling&Simulation-Digital Manufacturing
TO Number: 34-040002 **Revision:** 15

Period of Performance: 10/02/2010 to 03/31/2011

MSFC Initiator: Steven Phillips

(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	1	2	Unexpected cost increases in Rapid Prototype (RP) machine maintenance.
Risk T1	Technical	1	1	RP machine hardware and software updates could impact the ability to produce the required models.
Risk T2	Technical	1	2	Software developed for welding and assembly work Instructions may not work as expected.
Risk S1	Schedule	2	1	RP machine hardware and software updates could delay the production of required models.
Risk S2	Schedule	3	1	Problems developing software could result in the delay of welding and assembly work instructions.

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



