Marshall Space Flight Center
Engineering, Science & Technical Services

Task Order Plan (TOP)

Contract Number: *NNM05AB50C*
TO Title: *EM30 Metals Engineering Division Support*
TO Number: *34-030001* **Revision:** *16*

Period of Performance: *10/02/2010* to *9/30/2011*
MSFC Initiator: *Tim Vaughn*

(b)(4)

Emergency: *No*

Revision 16:
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. More specifically, subelements –CA, –CI, –CT, –CU, –CX, –DB and –DC were closed administratively during the CY5 Constellation Program replan. In addition, the following subelements were closed at the CY5 to CY6 transition: –00, –01, –02, –03, –08, –09, –61, –62, –99 and –EJ. The remaining Shuttle support previously performed under subelement –03 is now performed under subelements –SB, –SE, –SI, –SM and – ST. The Environmental Control and Life Support System (ECLSS) support previously performed under subelement –08 is now performed under subelement –JA.

1.0 Task Order Description & Objectives

Provide engineering and technical support to EM30 and EM31 in buildings 4602, 4612, 4705, 4752 and 4755.

EM30 is divided into two Branches consisting of four teams. The EM31 Failure Analysis and Metallurgy Branch is divided into the Metallurgical Engineering Team and the Materials Diagnostics Team. The EM32 Metal Joining and Processes Branch is divided into the Processes and Corrosion Team and the Welding and Manufacturing Team. Members of the different teams work closely together across team boundaries within EM30, with members of other divisions and branches within the Materials and Processes Laboratory, and with members of other MSFC, NASA and contractor organizations to support EM30 objectives/assignments. The members of the ESTS Group Metals Engineering Division Support Task are expected to perform their technical work equally seamlessly across these same boundaries while functioning administratively within the ESTS Group management system. In other words, the administrative management of the task and its members is controlled by the ESTS Group Performance Management System and the technical work is controlled by the EM30 ISO/AS9100 systems. Within those bounds, team members can and will give/accept technical direction to/from customer personnel and/or other contractor personnel to achieve EM30 objectives/assignments. Much of this work will be performed in conjunction with other NASA groups and companies such as equipment vendors and the Ares production contractors.

Some of the team's work will be collaborative - gathering and sharing technical know-ledge from/at meetings, telecons, e-mails and site visits. This collaborative process may also involve

providing input into and review of EM30 technical reports. Very little of the work will be broken down into specific, stand-alone tasks assigned to ESTS personnel and returned to the customer in the form of a formal deliverable. Inputs into the afore-mentioned collaborative processes will be the norm. In cases where specific, stand-alone tasks are performed, the work product will be returned to the customer in the form of an ESTS Group memo.

Specific projects to be supported and activities to be performed are listed in separate subelements below:
Subelement 04 – Spun-Formed Dome Support
Subelement 05 – EM32 Thermal Stir Welding Development
Subelement 06 – Space Act Agreement (SAA) Welding Development
Subelement 07 – Solidification Science and Flight Experiments Projects
Subelement JA – Environmental Control and Life Support System (ECLSS) Support
Subelement SB – Space Shuttle Solid Rocket Booster (SRB) Support
Subelement SE – Space Shuttle Man Engine (SSME) Support
Subelement SI – Space Shuttle Propulsion Systems Engineering and Integration (PSE&I) Support
Subelement SM – Space Shuttle Redesigned Solid Rocket Motor (RSRM) Support
Subelement ST – Space Shuttle External Tank (ET) Support

Additional subelements will be added to this Task Order Plan (TOP) as new projects requiring support are identified.

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

Subelement 04 - Spun-Formed Dome Support

- Develop an experimental approach to mitigate abnormal grain growth (AGG) during Al-Li 2195 friction stir welding, spin forming, and subsequent heat treatment. Verify the mechanical and metallurgical suitability of the resultant proposed process.

Subelement 05 – EM32 Thermal Stir Welding Development

- Coordinate machining and fabricating activities.
- Perform pin tool development.
- Prepare designed experiments to develop weld parameters.
- Perform welding.
- Machine test samples.
- Provide metallographic and photographic support.
- Perform statistical analysis.
- Perform an engineering review and quality check of the data.
- Prepare reports and data packages per customer requirements.
- Supervise welding.
- Perform miscellaneous tooling machining and fabricating activities.
- Plan and coordinate vendor upgrades to the TSW apparatus.
- Plan and coordinate the acquisition of an ultrasonic transducer.

Subelement 06 – SAA Welding Development

- Obtain required materials and services.
- Coordinate machining and fabricating activities.
- Perform pin tool development.
- Prepare designed experiments to develop weld parameters.
- Perform welding.
- Machine test samples.
- Provide metallographic and photographic support.
- Perform statistical analysis.
- Perform an engineering review and quality check of the data.
- Prepare reports and data packages per customer requirements.
- Supervise welding.

- Perform miscellaneous tooling machining and fabricating activities.

Subelement 07 – Solidification Science and Flight Experiments Projects
Rebuild/repair/modify three experimental furnace systems and make the science experiments equipment ready for relocation to building 4602.

Subelement JA – Environmental Control and Life Support System (ECLSS) Support
Provide weld engineering support for the electron beam (EB) welding of titanium tanks for the International Space Station ECLSS. These tanks will be manufactured by the customer. This support will generally consist of technical oversight of the welding per relevant standards (e.g. NASA-STD-5006), drawings and specifications and providing technical insight into solving problems or improving the process.

Subelement SB – Space Shuttle Solid Rocket Booster (SRB) Support
- Provide engineering insight and review of base metal and metallic component surface treatments including corrosion protection.
- Provide logistics support for task order subcontracting and procurements.

Subelement SE – Space Shuttle Main Engine (SSME) Support
- Provide metallurgical engineering, analysis, planning and support.

Subelement SI – Space Shuttle Propulsion Systems Engineering and Integration (PSE&I) Support
- Provide engineering insight and review of base metal and metallic component surface treatments including corrosion protection.

Subelement SM – Space Shuttle Redesigned Solid Rocket Motor (RSRM) Support
- Provide fracture mechanics engineering, analysis, planning and support.

Subelement ST – Space Shuttle External Tank (ET) Support
- Provide engineering insight and review of base metal and metallic component surface treatments including corrosion protection.
- Provide fracture mechanics engineering, analysis, planning and support.
- Provide metallurgical engineering, analysis, planning and support.

3.0 Discussion of Skills Required

Personnel supporting this task must have experience in:
- Performing materials diagnostics activities such as, but not limited to metallurgical failure analysis and preparation of metallographic samples.
- Evaluating corrosion protection schemes such as organic coatings and conversion coatings.
- Evaluating proposed metallurgical materials and processes for propulsion applications.
- Planning fracture mechanics characterization for manufacturing processes, developing design allowables from resultant test data, and applying resultant design allowables to manufactured hardware.
- Weld engineering.

4.0 Special Tools Required

Personnel Protective Equipment (PPE) appropriate to the performance of various operations (heat treating, corrosion testing, etc.) accomplished by task personnel.

5.0 Participating Subcontractors

Subelement SB – Space Shuttle Solid Rocket Booster (SRB) Support

(b)(4) provides a (b)(4) to evaluate corrosion protection schemes.

Subelement SI – Space Shuttle Propulsion Systems Engineering and Integration (PSE&I) Support

(b)(4) to evaluate corrosion protection schemes.

Subelement ST – Space Shuttle External Tank (ET) Support

(b)(4) to evaluate corrosion protection schemes.

6.0 Milestones & Deliverables

- Provide formal monthly activity reports.
- Schedule slips due to uncontrollable circumstances (examples: reprioritization of testing by customer; etc.) will not be factored negatively in assessing schedule objectives.
- A majority of the work performed is real time support and is negotiated with the requesting project at the time of receipt.
- Quality records for the electronic work request system data base must be received within 10 calendar days from the date of completion of the actual work.

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

Subelement 05 – EM32 Thermal Stir Welding Development

Materials: Pin tool materials.
Thermal Stir Weld System repair and upgrade components.

ODC: Machining services to produce pin tools.
Thermal Stir Weld System repair and upgrade services.

Subelement 06 – SAA Welding Development

Materials: Pin tool materials.
Thermal Stir Weld System repair and upgrade components.

ODC: Machining services to produce pin tools.
Thermal Stir Weld System repair and upgrade services.

Subelement 07 – Solidification Science and Flight Experiments Projects

Materials: Science system repair and upgrade components.

ODC: Science system repair and upgrade services.

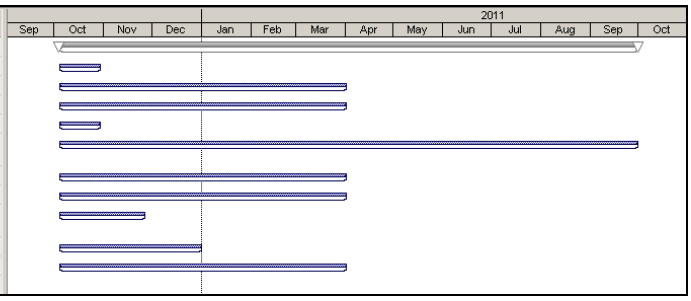
8.0 Work Shelf

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
34-030001		**EM30 Metals Engineering Division Support**
34-030001	04	Spun-Formed Dome Support
34-030001	05	EM32 Thermal Stir Welding Development
34-030001	06	SAA Welding Development
34-030001	07	Solidification Science and Flight Experiments Projects
34-030001	JA	Environmental Control and Life Support System (ECLSS) Support
34-030001	SB	Space Shuttle Solid Rocket Booster (SRB) Support
34-030001	SE	Space Shuttle Man Engine (SSME) Support
34-030001	SI	Space Shuttle Propulsion Systems Engineering and Integration (PSE&I) Support
34-030001	SM	Shuttle Redesigned Solid Rocket Motor (RSRM) Support
34-030001	ST	Space Shuttle External Tank (ET) Support



10.0 Previous Contract year Revision History

Revision 15:

This revision was initiated in response to the following changes in scope:

1. The customer required weld modeling assistance which could only be obtained from the Mississippi State University via a purchase order. This work was estimated as ODC in subelement -00. Updated sections 2.0, 6.0 and 7.0.
2. Increased non-Constellation heat treating labor support under subelement -01 due to the cancellation of some previously planned Constellation work. This increased the availability of these personnel to perform general heat treating support.
3. Decreased the (b)(4) subcontract estimate under subelement -02 due to the Constellation replan-related cancellation of work.
4. Added travel scope for materials engineer to travel to the Little League World Series to help the NASA Exploration Systems Mission Directorate staff an outreach trailer, exhibits and a sponsor tent by presenting the past, present and future of space exploration to the public. Updated sections 2.0 and 7.0.
5. Increased the labor support under subelement -03 due to the Constellation replan. This increased the availability of these personnel to perform non-Constellation work. Updated section 2.0 and 6.0 to define the additional work.
6. Create subelement -04 to capture the Al-Li 2195 spun-formed dome work previously captured under subelement -00. Develop an experimental approach to mitigate abnormal grain growth (AGG) during Al-Li 2195 friction stir welding, spin forming, and subsequent heat treatment. Verify the mechanical and metallurgical suitability of the resultant proposed process. Updated section 1.0, 2.0 and 6.0.
7. Renamed task to EM32 Thermal Stir Welding Support to differentiate it from future Space Act Agreement (SAA) supported thermal stir welding work. Increased support to Thermal Stir Welding Development under subelement -05 due to previous (non-ESTS) support personnel taking another job. ESTS was tasked with providing a weld technician to operate the Thermal Stir Welder (TSW), a weld engineer to serve as the TSW tool engineer, and miscellaneous weld technician and machinist support to perform small weld development programs and tooling development tasks. ESTS was also tasked with providing tooling support to plan and coordinate vendor modifications to the TSW. Updated sections 1.0 and 2.0.
8. Created subelement -06 to capture SAA welding development work. Updated sections 1.0, 2.0, 5.0 and 7.0.
9. Added labor support under subelement -07 to rebuild/repair/modify three experimental furnace systems and make the science experiments equipment ready for relocation to building 4602. Modified section 2.0.
10. Decreased the labor support because the customer believed it would take a full-time engineer to support this work. Once the work began progressing, it was realized that this work would not require full-time support. Increased the ODC scope of subelement -08 to obtain weld residual stress measurements. Updated sections 2.0 and 7.0.
11. Increased the scope of subelement -09 to add a second trip to support the Raleigh-Durham competition. Added labor to support this additional trip. Did not add additional travel estimate as the customer will pay this charge direct, not through the ESTS contract. Modified sections 2.0 and 7.0.
12. Increased the scope of subelement -61 to rebuild the alkali metals glovebox, help solve heat pipe welding issues and to help find a suitable site to operate the Safe and Affordable Fission Engine (SAFE). Modified section 2.0.
13. Increased the scope of subelement -62 to develop a portable powder vibrating table, develop cost estimates for in-house tantalum core and assembly, plan the future move of powders lab equipment to building 4602, and seek an amendment to the depleted uranium usage license to transfer it to the new location. Modified section 2.0.
14. Increased the scope of subelement -99 to help develop an experiment to determine the feasibility of anodizing a large barrel such as for a cryotank by rotating it through an anodizing bath instead of submerging it completely in such a bath. Modified section 2.0.
15. Reactivated subelement –EJ to provide technical insight into Launch Abort System fracture mechanics issues. Modified sections 1.0 and 2.0.

16. Also modified period of performance to match previous administrative change.

Revision 14:

This revision was initiated in response to the following increases in scope:

1. The Environmental Controls and Life Support System (ECLSS) program requested EM30 support which will require an additional ESTS (b)(4) This work is estimated under subelement -08.
2. The customer requested support for the For Inspiration and Recognition of Science and Technology (FIRST) robotic competition in Atlanta, Georgia. Created subelement -09 to estimate this work.
3. The customer requested support to plan and perform a stress corrosion cracking test program for the Friction Stir Weld Spun Form Dome Project. This work is estimated under subelement -00.

In addition, this revision:

1. Updates the name of this task order from "EM30 Metals Engineering Branch Support" to "EM30 Metals Engineering Division Support" throughout the task order documentation to reflect the recent Materials and Processess Laboratory reorganization. These changes were also updated in Section 1.0, "Task Order Description and Objectives."
2. Modifies several subelement titles to define acronyms contained in the titles.

This revision affects no APO elements.

Note: Subelements -07, -61, -62, -99, and -CI are currently placeholders. Additional details and estimate will be added to these subelements when the required support is defined.

Revision 13:

The purpose of this revision is to extend the Branch level, Materials Diagnostics Team, and Metallic Materials Engineering Team portions of task 34-030001 into Contract Year 5 of the NNM05AB50C ESTS contract. Task 34-030001 was growing too large and was divided into three portions with the customer's concurrence. This division of task 34-030001 also supports the customer's pending reorganization of EM30 from a branch into a division. 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 defines and estimates work for the period October 3, 2009 through October 14, 2010 based on the currently available Ares I Upper Stage (US) Integrated Master Schedule (IMS) and the agreed upon resource allocation. The IMS is expected to be updated in the next three to four weeks. This task order plan will be updated once the IMS is updated. This revision affects the following APO elements:

Subelement	WBS
-CA	136905.08.05.12.01.08
-CI	136905.02.99.02.08.10
-CT	136905.08.05.12.02.08.04
-CU	136905.08.05.12.02.08.05
-CX	136905.08.05.12.02.08.08
-DB	136905.08.05.12.06.08
-DC	136905.08.05.12.04.08

Note: Subelements -07, -08, -61, -62, -99, and -CI are currently placeholders. Based on the customer's IMS, it is anticipated that weld development personnel will end up performing plug welding on the MDA since they developed the technique. Additional details and estimate will be added to this subelement when the required support is defined.

CY1 through CY4 revision history is provided in section 10 at the end of this TOP.

REVISION 12:

This revision affects the following APO elements as follows:

Subelement	WBS	CY4 Change	CY5 Orders
(b)(4) [redacted]			

The **purposes of this revision are:**

1) Officially change the name of this task order in (b)(4) to "EM30 Metals Engineering Branch Support." The original task (subelement -02) was for a (b)(4) supporting metallic materials processes development only. The task has grown to support a variety of work across EM30, but the task name was never officially changed in (b)(4) to match the nomenclature in common use by ESTS and customer personnel. This revision implements this name change.
2) **Subelement -01:**
   a. Reduced labor estimate to free up the (b)(4) to perform materials logistics in support of the Upper Stage weld allowables and weld process development programs (subelements -CA and -CR, respectively) and to perform heat treating in support of the Shuttle hydrogen repressurization valve failure (subelement -03); and to free up the heat treating technician labor to perform heat treating in support of the Shuttle hydrogen repressurization valve failure, Upper Stage weld process development and component development programs (subelements -03, -CR and -CT, respectively).
3) **Subelement -02:**
   a. Increased labor estimate to manage the (b)(4) due to increased scope of work.
   b. Increased (b)(4) subcontracting estimate due to increased scope of work. Customer desires additional data acquisition support for fusion welding development above and beyond the friction stir welding data acquisition development. Details in section 5.0.
4) **Subelement -03:**
   a. Increased labor estimate to perform heat treating in support of the Shuttle hydrogen repressurization valve failure. This failure was not anticipated when the task was estimated.
   b. Increased travel estimate to send an employee to view the launch of STS-125 in support of the Space Flight Awareness program. This award was not anticipated when the task was estimated. Details in section 7.0.
   c. Increased ODC estimate to ship materials in support of the Shuttle hydrogen repressurization valve failure. This failure was not anticipated when the task was estimated. Details in section 7.0.
5) **Subelement -61:**
   a. Decreased labor estimate due to less work in this area than previously estimated. The customer for this task has been heavily involved in the Ares I project and has not had as much time to work on research projects as was originally planned.
   b. Decreased material to account for needing less purge gas to operate the gloveboxes than was originally estimated. Details in section 7.0.

6) **Subelement -62:**
   a. Decreased labor estimate due to less work in this area than previously estimated. The customer for this task has been heavily involved in the Ares I Upper Stage common Bulkhead project and has not had as much time to work on research projects as was originally planned.
   b. Increased material estimate to account for additional purge gas purchases. Although the customer research activity has been less than originally planned, another customer has asked to store some materials in the Powders Laboratory glovebox. This required operating the glovebox purge more than was originally planned. Details in section 7.0.
7) **Subelement -99:**
   a. Increased labor estimate to perform several small, short-term projects including: evaluating an ion milling system for the failure analysis laboratory, determining the correlation between electrical conductivity and hardness of 2219 aluminum, and examining the microstructure and fractography of a titanium alloy which performed better than expected during hydrogen testing. This work was not known during the last task order revision.
   b. Increased material estimate to obtain 192 feet of 2219 and 2014 aluminum bar stock for friction plug welding development. This material was needed to continue welding development while the 2195 aluminum plug development program was solving the low strength problem. This problem was not anticipated during the last task order revision. Details in section 7.0.
   c. Increased ODC to certify a friction stir welding manufacturing engineer to perform visual weld inspections through the American Welding Society at the customer's request. The customer requested this action after the last task order revision. Details in section 7.0.
8) **Subelement -CA:**
   a. Decreased labor estimate due to delays in performing weld allowables welding. The customer schedule anticipated performing more weld allowables welding this year. But longer than expected friction plug welding weld development delayed the start of weld allowables testing. This reduced the amount of allowables welding which could be performed this year.
   b. Decreased material estimate due to 2219 aluminum for weld allowables welding, which was ordered in August. Because the invoice(s) won't be paid this contract year no cost estimate is shown but instead will be estimated on the task order revision that continues this work into the next contract year, CY5. The estimated cost for this is (b)(4)
   c. Decreased travel estimate due to less (b)(4) travel than anticipated. This year's estimate was based on last year's estimate and less travel was requested this year as the Machining Center is being installed at MSFC and the Manufacturing Planner's supervision of the project shifted to MSFC. Details provided in section 7.0.
   d. Increased subcontractor estimate due to increased (b)(4) support to the Ground Vibration Test Article. The Manufacturing and Assembly Control Board expanded the corrosion testing program to include fasteners. Details provided in section 5.0.
   e. Decreased ODC estimate due to a maintenance contract for the Process Development System and the Robotic Weld Tool which will be ordered in August or September. Because the invoice(s) won't be paid this contract year no cost estimate is shown but instead will be estimated as a no-fee subcontract on the task order revision that continues this work into the next contract year, CY5. The estimated cost for this is (b)(4)

These changes reduced the cost estimate for this subelement by (b)(4)

9) **Subelement -CR:**
   a. Increased labor estimate due to increased scope of work. The customer recently developed a comprehensive weld development project schedule similar to the manufacturing development schedule. The weld development schedule revealed that the customer is very behind on weld development panel welding. As a result, the manufacturing development schedule has been adjusted to bring several additional welding machines to

bear welding additional weld development panels. This increase provides the ESTS portion of the labor to execute that plan.

b. Increased material estimate due to increased scope from the customer. ESTS was tasked with producing pin tools in house. It was necessary to obtain MP159 tool steel from which to manufacture these pin tools. Details provided in section 7.0. Additional MP159 will be ordered in August or September. Because the invoice(s) won't be paid this contract year no cost estimate is shown but instead will be estimated on the task order revision that continues this work into the next contract year, CY5. The estimated cost for this material is (b)(4) 2219 aluminum for weld development welding was ordered in early August. Because the invoice(s) won't be paid this contract year no cost estimate is shown but instead will be estimated on the task order revision that continues this work into the next contract year, CY5. The estimated cost for this material is (b)(4)

c. Increased travel estimate due to increased scope of work. The customer requested that (b)(4) travel to a vendor's site to help evaluate a new Friction Plug Welding system by performing plug welds to be made by the vendor at their facility. Details provided in section 7.0.

These changes increased the cost estimate for this subelement by (b)(4)

10) Subelement –CT:

a. Increased labor estimate due to increased scope of work. Helped the customer resolve greater than anticipated problems developing the Ares I Upper Stage components including: investigating and helping the ring forging and spin forming vendors resolve low strength properties, investigating the cause(s) of gore panel failures during stretch forming, and investigating formability differences between the two Al-Li 2195 vendors.

b. Increased material estimate to obtain paint markers to mark metal components and steel drums to support panels during heat treating operations. Details provided in section 7.0. 2219 aluminum rod from which to make friction plug welding plugs was ordered in July. Because this is a long-lead item and the invoice(s) won't be paid this contract year no cost estimate is shown but instead will be estimated on the task order revision that continues this work into the next contract year, CY5. The estimated cost for this material is (b)(4)

c. Decreased travel estimate due to work being accomplished with less travel than initially anticipated. Details provided in section 7.0.

These changes increased the cost estimate for this subelement by (b)(4)

11) Subelement –CU:

a. 2219 aluminum for corrosion protection testing was ordered in August. Because the invoice(s) won't be paid this contract year no cost estimate is shown but instead will be estimated on the task order revision that continues this work into the next contract year, CY5. The estimated cost for this is (b)(4)

12) **Subelement -CV:**

a. Increased labor estimate due to increased scope of work. ESTS was tasked with taking over Y-Ring fixture and the Vertical Trim Tool (VTT) assembly when the original (non-ESTS) assemblers service proved unreliable. A number of individual piece parts required ESTS modification/rework during fixture assembly. Reworking incorrect parts was not included in the previous estimate, but was necessary to meet schedule milestones.

b. Increased material estimate due to increased scope of work. ESTS was tasked with taking over Y-Ring fixture and the Vertical Trim Tool (VTT) assembly when the original (non-ESTS) assemblers service proved unreliable. This required ESTS to procure miscellaneous hardware not provided by the customer to assemble the Y-Ring fixture the VTT. Details provided in section 7.0.

c. Increased travel estimate due to increased scope of work. ESTS was tasked with providing a turn-key solution adapting the Aronson turntable (existing unused customer

hardware in storage at the Michoud Assembly Facility (MAF)) to perform Common Bulkhead seal plate welding development at MSFC. To execute this project, ESTS personnel traveled to MAF to review the positioning table which will be incorporated into the Seal Weld Tool (SWT) and coordinate transfer of the table and associated hardware to MSFC. It was also necessary to pay interview travel costs for the CNC programmer mentioned below. Details provided in section 7.0.

d. Increased no-fee tooling design subcontract estimate due to an increase in scope. ESTS has been tasked with providing a turn-key solution to ready the Aronson positioning tool for Common Bulkhead seal plate welding development (creating the Seal Weld Tool (SWT)). This increase funds the subcontract through the end of CY4 (including SWT Preliminary Design Review (PDR)). Details provided in section 5.0. In addition, this subcontract will extend into CY5. Because those invoice(s) won't be paid this contract year, only the cost estimate for CY4 is shown. The cost for Critical Design Review (CDR) will be estimated on the task order revision that continues this work into the next contract year, CY5. The cost for SWT fabrication and integration will be estimated at an appropriate stage of review agreed upon with the customer and once the vendor can supply a firm, fixed-price estimate for fabrication and integration. The current ROM cost for fabrication and integration is shown for informational purposes only. The estimated costs for the CY5 portion of this work are:
    i. SWT Critical Design Review = (b)(4) (firm, fixed-price estimate).
    ii. SWT Fabrication and Integration = (b)(4) (rough order of magnitude (ROM) estimate).
e. Added no-fee subcontract estimate to obtain a (b)(4) to help the VTT control system programmers understand how to implement the operator interface screens based on the G-Code CNC machine tool programming language and large-scale aerospace machining/manufacturing practice. Details provided in section 5.0. In addition, this subcontract will extend into CY5. Because those invoice(s) won't be paid this contract year, only the cost estimate for CY4 is shown. The balance will be estimated on the task order revision that continues this work into the next contract year, CY5. The estimated cost for the CY5 portion of this work is (b)(4)
f. Increased ODC estimate due to increased scope of work. ESTS was tasked with taking over assembly of the Y-Ring fixture and the Vertical Trim Tool (VTT) when the original assembly service proved unreliable. This required ESTS to procure miscellaneous machining services not provided by the customer (too large for machine tools ESTS personnel operate) to modify tooling weldments. Details provided in section 7.0.

These changes increased the cost estimate for this subelement by (b)(4)

13) **Subelement -CW:**
    a. Reduced labor estimate due to delays in starting Common Bulkhead welding program. The Y-Ring fixture problems mentioned in subelement –CV delayed the start of the Common Bulkhead welding program, which reduced how much work will be performed in CY4.
    b. Increased travel estimate for personnel to travel to Michoud Assembly Facility (MAF) to participate in a Common Bulkhead welding Technical Interchange Meeting (TIM). Details provided in section 7.0.

These changes reduced the cost estimate for this subelement by (b)(4)

14) **Subelement -CX:**
    a. Decreased labor estimate to complete the Manufacturing Demonstration Article welding. The barrel welding was completed with fewer resources than originally planned.

These changes reduced the cost of this subelement by (b)(4)

REVISION 11:

The purposes of this revision are:

1) **Subelement -00:** Increased labor estimate due increased scope of procurement. This increased the cost of this subelement by (b)(4)
2) **Subelement -01:** Increased labor estimate due to increased scope of Heat Treatment Facility operations including furnace control systems upgrades and developing a secondary containment approach for the quench tanks. Increased materials estimate to acquire components for furnace control systems upgrades. This increased the cost of this subelement by (b)(4)
3) **Subelement -02:** Decreased labor estimate due to decreased scope of work (did not add work to subcontract as originally anticipated, which decreased labor to manage subcontract). This decreased the cost of this subelement by (b)(4)
4) **Subelement -03:** Increased labor estimate due to increased scope of Shuttle Support (repressurization valve failure investigation). This increased the cost of this subelement by (b)(4)
5) **Subelement -05:** Increased labor estimate due to increased scope of Thermal Stir Welder checkout support. Increased ODC estimate to modify Thermal Stir Welder components and to transport display to and from an off-site meeting including local handling. This increased the cost of this subelement by (b)(4)
6) **Subelement -07:** Increased labor estimate due to increased scope (obtain replacement anode for Rigaku X-ray Generator). This increased the cost of this subelement by (b)(4)
7) **Subelement -08:** Create subelement to support Water Distillation Apparatus failure investigation. The cost of this subelement is estimated at (b)(4)
8) **Subelement -61:** Decreased labor estimate due to decreased scope of work due to ongoing Constellation work. Increased material estimate to acquire inert gases for purging glove boxes. Increased ODC estimate to ship a new vacuum chamber from the vendor to MSFC. This increased the cost of this subelement by (b)(4)
9) **Subelement -62:** Increased labor estimate due to increased scope work (obtaining inert gases for purging the High-Temperature Powders Laboratory glove boxes). Increased Material estimate to acquire inert gases for purging the High-Temperature Powders Laboratory glove boxes. Increased ODC estimate to acquire plasma processing of experimental high-temperature materials. This increased the cost of this subelement by (b)(4)
10) **Subelement -99:** Increased labor estimate due to increased scope of procurement activities. Added materials estimate to acquire equipment required to perform heat treatment for the delamination study and to obtain replacement tooling parts for the Robotic Weld Tool. Added ODC estimate to repair the Process Development System. This increased the cost of this subelement by (b)(4)
11) **Subelement –AM:** Changed the WBS from 206518.02.99.01.08.05 to 206518.08.03.20. Decreased labor estimate due to decreased effort to manage the subcontract. This decreased the cost of this subelement by (b)(4)
12) **Subelement –CA:** Increased labor estimate due to increase in scope (added Friction Stir Weld Manufacturing Development Facility equipment assembly and integration). Increased material estimate for 2219 aluminum for the weld allowables program. Increased travel estimate to reflect Manufacturing Planner travel (MAF space utilization planning, Machining Center, etc.) planned for the second half of the contract year. Increased subcontractors estimate due to increased scope (Ground Vibration Test Article corrosion protection scheme testing and evaluation). Increased ODC estimate to obtain a service contract via a blanket purchase order for the Robotic Weld Tool and the Process Development System. This increased the cost of this subelement by (b)(4)

13) **Subelement –CB:** Close at the end of the accounting period 5. Increased travel estimate due to (b)(4) Travel (RWT II PDR at MAF, RWT III CDR at MTS). Increased subcontractors estimate due to increased scope (Upper Stage external primer corrosion protection requirements and testing A286 fasteners installed into Al-Li 2195 blocks using chrome-free paste). Added ODC estimate due to recruiting expenses. This increased the cost of this subelement by (b)(4)

14) **Subelement –CD:** Reduced scope of this subelement at customer's request from overall J-2X support to J-2X turbomachinery support only. Reduced labor estimate due to the decreased scope of work. However, estimate in history (before March, 2009) could not be removed. ESTS will monitor work to not exceed (b)(4) abor hours as requested by J-2X element. This decreased the cost of this subelement by (b)(4)

15) **Subelement –CE:** Reduced labor estimate due to decreased scope of work (customer's budget limitations). This decreased the cost of this subelement by (b)(4)

16) **Subelement –CR:** Decreased labor estimate due to clarified scope of friction plug weld development and seal plate welding development. Increased material estimate for 2219 aluminum to be purchased for seal plate welding development. This decreased the cost of this subelement by (b)(4)

17) **Subelement –CS:** Added labor estimate to manage subelement. It is a placeholder at this time. This increased the cost of this subelement by (b)(4)

18) **Subelement –CT:** Increased Component Engineer labor estimate due to increased scope (additional component development support and writing component specifications). Decreased (b)(4) abor estimate due to less than expected heat treatment development. Added travel estimate to reflect (b)(4) travel the first half of the year and estimated for the second half of the year. This decreased the cost of this subelement by (b)(4)

19) **Subelement –CU:** Decreased labor estimate due to clarified scope of surface treatment development. This decreased the cost of this subelement by (b)(4)

20) **Subelement –CV:** Increased labor estimate due to additional Y-Ring Fixture assembly support. Increased material estimate to obtain:
    a. Nuts, bolts, washers and other miscellaneous hardware not provided by the customer to assemble the Y-Ring Fixture.
    b. Two dome-loaded regulators and a hand valve for the Vertical Weld Tool clamp air supply not supplied by the customer.

    Increased travel estimate to account for (b)(4) travel to pull plug welding vendors. Added estimate for a no-fee subcontract to obtain short-term weld tooling design work from a vendor already familiar with existing equipment relocated from other customers facilities. Added ODC estimate to ship materials needed by the (b)(4) during trip to one pull plug welding vendor. This increased the cost of this subelement by (b)(4)

21) **Subelement –CW:** Decreased labor estimate based on latest Integrated Master Schedule and estimated availability of the Y-Ring Fixture for loading on the Robotic Weld Tool. This decreased the cost of this subelement by (b)(4)

22) **Subelement –CX:** Created subelement starting at the beginning of accounting period 6 to replace –CB to change WBS associated with work. The estimate is based on the current status of work and may change later based on when the Y-Ring Fixture becomes available for loading on the Robotic Weld Tool. The initial estimate for this subelement is (b)(4)

23) **Subelement –DA:** Created subelement –DA per customer's request to separate J-2X metallic nozzle extension work from overall J-2X support previously provided under subelement –CD. The initial estimate for this subelement is (b)(4)

24) **Subelement –EJ:** Reduced labor estimate due to decreased scope of work (customer's budget limitations). This decreased the cost of this subelement by (b)(4)

The overall change in cost to this task order due to this revision is an increase of (b)(4)

The current APO elements are as follows:

Subelement	WBS
-AM	206518.08.03.20
-CA	136905.08.05.12.01.08
-CD	136905.08.04.01.08.08
-CE	136905.08.01.11
-CI	136905.02.99.02.08.10
-CR	136905.08.05.12.02.08.02
-CS	136905.08.05.12.02.08.03
-CT	136905.08.05.12.02.08.04
-CU	136905.08.05.12.02.08.05
-CV	136905.08.05.12.02.08.07
-CW	136905.08.05.12.02.08.11
-CX	136905.08.05.12.02.08.08
-DA	136905.08.04.01.08.11
-EJ	644423.06.34.03.10.08

REVISION 10:

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 following APO elements:

Subelement	WBS
-AM	206518.02.99.01.08.05
-CA	136905.08.05.12.01.08
-CB	136905.08.05.12.02.08
-CD	136905.08.04.01.08.08
-CE	136905.08.01.11
-CI	136905.02.99.02.08.10
-CR	136905.08.05.12.02.08.02
-CS	136905.08.05.12.02.08.03
-CT	136905.08.05.12.02.08.04
-CU	136905.08.05.12.02.08.05
-CV	136905.08.05.12.02.08.07
-CW	136905.08.05.12.02.08.11
-EJ	644423.06.34.03.10.08

CY1, CY2 and CY3 revision history is provided in section 10 at the end of this TOP.

REVISION 09:

This TO Revision 09 revises subelements -00, -01, -02, -03, -62, -CA, -CB, CE, and –EJ. Specific sub-element detail is provided below. The total task order estimate is decreased from (b)(4) to (b)(4)

This revision affects the following Ares Project Office (APO) elements:

- Upper Stage, Ares I (-CA and –CB)
- First Stage, Ares I (-CE)
- Launch Abort System, Orion (-EJ).

Subelement -00 (Revised):

Material:

Increased material estimate (b)(4) to acquire a control console to house the Vertical Weld Tool non-destructive evaluation controls.

Decreased material estimate (b)(4) to account for two machine tools (a CNC mill and a CNC wire EDM machine) which were ordered this contract year but will not be received and installed until next contract year.

Paragraph 7.0 further defines the non-labor effort supporting this cost estimate.

The total subelement estimate decrease is (b)(4)

Subelement -01 (Revised):

Material:

Decreased material estimate (b)(4) due to obtaining heat treatment equipment upgrades with fewer resources than originally estimated.

Other Direct Charges:

Decreased other direct charges estimate (b)(4) o account for equipment maintenance, recertification and training services which were ordered this year but which will not be completed and paid for until next contract year.

Paragraph 7.0 further defines the non-labor effort supporting this cost estimate.

The total subelement estimate decrease is (b)(4)

Subelement -02 (Revised):

No-Fee Subcontracts:

Increased no-fee subcontracts estimate (b)(4) to accommodate increased weld controls engineer scope of work.

Paragraph 7.0 further defines the non-labor effort supporting this cost estimate.

The total subelement estimate increase is (b)(4)

Subelement -03 (Revised):

Travel:

Increased travel estimate (b)(4) to account fracture mechanics engineer vendor visit to witness STS servovalve inspection.

No-Fee Subcontracts:

Increased no-fee subcontracts estimate (b)(4) to accommodate increased corrosion engineer scope of work.

Paragraph 7.0 further defines the non-labor effort supporting this cost estimate.

The total subelement estimate increase is (b)(4)

Subelement -62 (Revised):

Material:

Increased material estimate (b)(4) to obtain cutting tools to process samples.

Other Direct Charges:
Decreased other direct charges estimate (b)(4) due to obtaining additional plasma processed rhenium samples with fewer resources than originally estimated.

Paragraph 7.0 further defines the non-labor effort supporting this cost estimate.

The total subelement estimate decrease is (b)(4)

Subelement -CA (Revised):
This revision affects the following APO Element: Ares I Upper Stage Integrated Manufacturing and Assembly WBS# 136905.08.05.12.01.08.

Labor:
Increased labor estimate by (b)(4) hours to account for (b)(4) overtime.

Travel:
Increased travel estimate (b)(4) for additional (b)(4) travel to Machining Center CDR.

No-Fee Subcontracts:
Increased no-fee subcontract estimate (b)(4) to accommodate increased (b)(4) scope of work.

Other Direct Charges:
Increased other direct charge estimate (b)(4) to account for recruiting costs.

Paragraph 7.0 further defines the non-labor effort supporting this cost estimate.

The total subelement estimate increase is (b)(4)

Subelement -CB (Revised):
This revision affects the following APO Element: Ares I Upper Stage Lox and LH_2 Tank and Structural Test Articles WBS# 136905.08.05.12.02.08.

Labor:
Increased labor estimate:

(b)(4)

Material:
Increased material estimate:

(b)(4)

The total increase in material estimate is (b)(4)

Travel:

Increased travel estimate (b)(4) to account for several trips by the (b)(4) (b)(4) to visit materials and component vendors.

No-Fee Subcontracts:
Decreased no-fee subcontract estimate (b)(4) due (b)(4) being accomplished with fewer resources than originally estimated.

Other Direct Charges:
Increased other direct charges estimate:

(b)(4)

The total increase in other direct charges estimate is (b)(4)

Paragraph 7.0 further defines the non-labor effort supporting this cost estimate.

The total subelement estimate increase is (b)(4)

Subelement -CE (Revised):
This revision affects the following APO Element: Ares I 1st Stage RSRMV WBS# 136905.08.01.11.

No-Fee Subcontracts:
Increased no-fee subcontract estimate (b)(4) to accommodate increased (b)(4) scope of work.

Paragraph 7.0 further defines the non-labor effort supporting this cost estimate.

The total subelement estimate increase is (b)(4)

Subelement -EJ (Revised):
This revision affects the following APO Element: Orion Launch Abort System. No WBS# is available at this time.

No-Fee Subcontracts:
Increased no-fee subcontract estimate (b)(4) to accommodate increased (b)(4) scope of work.

Paragraph 7.0 further defines the non-labor effort supporting this cost estimate.

The total subelement estimate increase is (b)(4)

Revision 08:

The purposes of the revision are:

1. Add greater detail to Section 1.0, “Task Order Description and Objectives.”
2. **Subelement -00** Added procurement of the following items:
   a. A computer numerically controlled (CNC) milling machine (b)(4) and a CNC wire electrical discharge machine (b)(4) for the processes development machine shop
   b. An additional weld system control console (b)(4)
   c. A crane lift spreader bar (b)(4)

   These changes resulted in a net increase to this subelement of (b)(4)

3. **Subelement -03** Increased (b)(4) labor to support increased scope of work via the existing no-fee subcontract. This change resulted in a net increase to this subelement of (b)(4)
4. **Subelement -61** Increased (b)(4) labor to support increased scope of work. This change resulted in a net increase to this subelement of (b)(4)
5. **Subelement -99** Increased (b)(4) (b)(4) labor to support an increased scope of work. This change resulted in a net increase to this subelement of (b)(4).
6. **Subelement -CA** Decreased (b)(4) labor due to delayed start of Main Propulsion Test Article work and allowables work. Increased (b)(4) travel due to several visits to Michoud Assembly Facility to resolve equipment location issues, machining and fabrication facilities to review their capabilities for possible CLV use, equipment vendors to participate in machining center design reviews, and Glenn Research Center to participate in a manufacturability review. Increased (b)(4) labor to support increased scope of work via the existing no-fee subcontract. These changes resulted in a net **decrease** to this subelement of (b)(4)
7. **Subelement -CB:** Added (b)(4) to support an increased scope of work under subelement -CB, "Ares I CLV LOX and LH2 Tank and Structural Test Articles." (b)(4) of these (b)(4) will possess welding and/or aerospace fabrication experience (b)(4) while the other (b)(4) will be more (b)(4) with aerospace friction stir welding and friction stir weld equipment experience. Added procurement of a vertical weld tool threaded pin tool adapter (b)(4). Increased material estimate to account for several large mill runs of aluminum procured to support Manufacturing Demonstration Article (MDA) weld development and miscellaneous shop supplies (b)(4). Increased travel for (b)(4) supporting technical interchange meetings at (b)(4) at (b)(4) (b)(4) These changes resulted in a net increase to this subelement of (b)(4)
8. **Subelement -CE:** Increased (b)(4) support and materials estimate for shop supplies needed to perform for D6AC heat treating studies. Increased (b)(4) to support increased scope of work via the existing no-fee subcontract. These changes resulted in a net increase to this subelement of (b)(4)

The changes to subelement estimates listed above resulted in a net increase to the task of (b)(4)

Revision 07:

The purpose of this revision is to update the labor estimate for changes in staffing and to update the non-labor estimates for changes in procurements. Changes in overall labor were due to: two personnel leaving the team, one of whom was replaced; accounting for the actual start dates of three new personnel estimated in the previous revision before their exact start dates were known; overtime expended to date to complete time critical tasks; and redistribution of the estimate to account for the customer's increased workload distribution definition. This resulted in a net reduction in estimated labor hours of (b)(4) hours. The additional procurements resulted in a net increase to the overall task of (b)(4) Additional details are as follows:

<u>-00: Metals Engineering Branch Support</u>
Added labor estimate for administrative support. Updated branch-wide lab coat estimate to reflect change from billing lab coats as other direct charges (ODC) as originally estimated to billing them as materials. Also increased estimate to reflect increased usage.

-01: Heat Treatment Facility Operations & Maintenance
Adjusted labor charges to reflect one (b)(4) technician obtaining his electrical engineering degree and moving to support the Damage Tolerance Assessment Branch. His full-time support was replaced by a combination of support by an (b)(4) to direct heat treating activities and (b)(4) to perform heat treatment equipment control systems upgrades. Delayed the Hot Isostatic Press (HIP) system maintenance, recertification and operator training activity several months to accommodate heat treatment process development studies performed

under subelement –CE. Added several procurements for services and materials to upgrade heat treatment equipment control systems.

-02: Friction Stir Welding Electronic Data Processing
Balanced labor charges to reflect work performed on, and estimated ODC and materials needed for the Thermal Stir Welder work before a new subelement (-05) was created to capture this work separately. Updated non-labor no-fee subcontract estimate for (b)(4) (b)(4) subcontract to account for delayed CY2 billing and delayed start of CY3 billing due to subcontracting delays.

-03: Space Shuttle Support
Renamed subelement to reflect expanding scope of work from supporting External Tank (ET) metallic components to supporting all Metals Engineering Branch Space Shuttle work. Updated labor estimate to reflect promotion of (b)(4) from (b)(4) labor category and (b)(4) (b)(4)

-04: Army Failure Analysis
Closed subelement.

-05: Thermal Stir Welding Development
Balanced labor charges to reflect work performed on, and estimated materials needed for Thermal Stir Welder work under this subelement. This subelement was created to separate this work from the Friction Stir Welding Electronic Data Processing work performed under subelement -02.

-07: Solidification Science and Flight Experiments Projects
Reduced labor estimate to reflect decreased activities in this area. Added non-labor materials estimate for lab coats.

-61: Nuclear Power Support
Reduced labor estimate to reflect decreased activities in this area. Moved and adjusted non-labor materials estimate to account for actual cost and changes in delivery dates from previous estimate. Added conference registration as non-labor ODC estimate and travel costs for (b)(4) (b)(4) to transport hardware to STAIF 2008 conference, display the hardware at the conference, and return the hardware to MSFC. The (b)(4) also gained technical knowledge attending the conference.

-62: Nuclear Power IRAD Support
Reduced labor estimate to reflect decreased activities in this area. Added non-labor materials estimate to procure two sets of specially processed, high-temperature alloys specimens for in-house testing.

-99: Short-Term Support
Increased labor estimate to account for Space Station fastener study. Increased (b)(4) (b)(4) to account for Solid Rocket Booster (b)(4) work performed via (b)(4) (b)(4)

(b)(4)

(b)(4) [redacted]

-CA: Ares I CLV Integrated Manufacturing and Assembly
Increased work definition to include first stage roll control system support and ground vibration test article support. Added labor estimate for (b)(4) [redacted] transitioning from –AM. Reduced other labor estimate to reflect changes in work area definition, resulting in an overall reduction in labor. Added estimate for (b)(4) [redacted] to travel to MAF to coordinate internal government transfer of excess ET LOX dome gores and a quarter-dome weld fixture to MSFC. These materials and equipment will be used to produce a quarter dome to demonstrate that the new MSFC Robotic Weld Tool (RWT) and operators are ready to begin producing ARES I CLV hardware. Added non-labor ODC estimate for a cell phone provided to an (b)(4) [redacted] at the customer's request. Added non-labor ODC estimate for (b)(4) [redacted] Added (b)(4) [redacted] non-labor no-fee subcontract estimate for Ground Vibration Test support. These changes resulted in a net reduction of (b)(4) [redacted] for this subelement.

-CB: Ares I CLV LOX and LH2 Tank and Structural Test Articles
Reduced labor estimate to account for changes in work distribution across the task. Also reduced labor estimate to account for (b)(4) [redacted] out for long-term illness and about four weeks of time between (b)(4) [redacted] moving to another contract within his company and the start of his replacement. Added non-labor ODC for relocation of (b)(4) [redacted] and adjusted distribution of (b)(4) [redacted] between this subelement and –AM to account for changes in relocation allocation. Added travel for (b)(4) [redacted] to visit the Y-ring roll forging vendor to understand problems achieving the expected/required Y-ring mechanical properties. Added (b)(4) [redacted] recruiting and relocation. Added two trips for (b)(4) [redacted] (b)(4) [redacted] to travel to the gore panel stretch forming vendor to examine tooling during the development process and to witness forming of the first gore panel. Updated the non-labor materials estimate to ship a large ingot to a heat treating vendor and to heat treat the ingot to match actual costs and delivery schedules. The ingot was too large to fit into any of the MSFC heat treating furnaces. The ingot will be processed at another vendor into rods from which weld plugs will be fabricated. Updated the non-labor materials estimate for a laser shrink gage to be used during friction stir welding to match actual cost and delivery schedule. Added (b)(4) [redacted] for miscellaneous shop supplies used by ESTS personnel in the course of their daily work. Moved non-labor material estimate for mill-run aluminum plate material to later in the year to reflect delays by the vendor in delivering this material. This material will be used to fabricate a variety of components such as weld development test panels. Added (b)(4) [redacted] non-labor no-fee subcontract estimate for Manufacturing Demonstration Article support. These changes resulted in a net reduction of (b)(4) [redacted] for this subelement.

-CD: Ares I CLV J2-X Engine
Increased labor estimate to account for changes in work distribution across the task. These changes resulted in a net increase of (b)(4) [redacted] for this subelement.

-CE: CLV 1st Stage/RSRM V
Increased labor estimate to account for changes in work distribution across the task. These changes resulted in a net increase of (b)(4) [redacted] for this subelement.

-CI: CLV Nuclear Power Support
Decreased labor estimate to account for changes in work distribution across the task. Added (b)(4) [redacted] material estimate to account for actual and expected liquid argon used in the laboratory. These changes resulted in a net decrease of (b)(4) [redacted]

-EJ: Orion CEV Launch Abort System
Decreased labor estimate to account for changes in work distribution across the task. Reduced (b)(4) [redacted] (b)(4) [redacted] estimate to account for actuals and changes in work distribution across the task. These changes resulted in a net decrease of (b)(4) [redacted]

Revision 06:

The purpose of revision 06 is to add a (b)(4) to task order CA. This increased the cost of this task order and subelement CA by (b)(4)

Revision 05:

The purpose of revision 05 is 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 any changes in task activities for the new period of performance. CY2 revision history is provided in section 10 at the end of this TOP.

(b)(4)

Revision 04:

This revision reduced labor estimate from (b)(4) to (b)(4) hours and reduced total estimate from (b)(4) to (b)(4). The labor reduction was due to positions estimated in CY02 and then not expended as follows:

(b)(4)

Subelement -01: increased estimate to procure metallograph for diagnostics facility per customer's request (b)(4) Also changed title from "Maintenance" to "Heat Treat Facility Operations and Maintenance" to better reflect activities performed under this subelement. This revision authorizes procuring hot isostatic press system inspection, recertification and training services in CY02 at the customer's request (b)(4), which will not be paid for and therefore will not be estimated until CY03.

Subelement -02: reduced subcontracting estimates due to work accomplished with fewer resources than originally estimated. Added labor to perform thermal stir welding and estimate to procure thermal stir welding supplies and thermal stir welding apparatus modifications.

Subelement -04: reduced estimate due to work accomplished with fewer resources than originally estimated.

Subelement -07: added trip including truck rental to Argonne National Laboratory and Iowa State University to deliver, set up and operate the electrostatic levitator and the zone refining furnace.

Subelement -50: moved this work to newly-created subelement -CM starting period 12 per the customer's request. Estimate through period 11 increased to reflect procured manufacturing planning activities (b)(4) This revision authorizes the entire procurement (b)(4) split between subelement -CB (half of cost up to a total of (b)(4) and this subelement (remainder or (b)(4) The first two installments (b)(4) were estimated in this subelement. The remaining CY02 installment (b)(4) was estimated in subelement -CM as will the remaining work to be completed in CY03 (b)(4) Subelement -50 will become inactive at the end of period 11.

Subelement -61: increased estimate to procure turbopump for nuclear power simulation apparatus per customer's request. This revision also authorizes procurement of a scroll pump (b)(4) and vacuum chamber (b)(4) for the nuclear power simulation apparatus in CY02 per customer's request, but which will not be received and/or paid for in CY02 and therefore will not be estimated until CY03.

Subelement -63: increased estimate to procure requested services for special materials research per customer's request.

Subelement -99: increased estimate to procure digital cameras for diagnostics facility per customer's request (b)(4)

Subelement –CA: reduced estimate due to work accomplished with fewer resources than originally estimated.

Subelement –CB: decreased labor estimate due hiring actions described above. Increased estimate to procure (b)(4). The first three installments (b)(4) (b)(4) and (b)(4) were estimated in CY02. The remaining installments (totaling (b)(4) won't be paid for in CY02 and therefore will be estimated in CY03. This revision also authorizes procurement of a laser weld shrinkage gauge (b)(4) heat treating services to homogenize an aluminum lithium ingot which is too large to heat treat in house (b)(4) procurement of aluminum lithium and 2014 aluminum plate to support CLV fabrication efforts (roughly estimated at (b)(4) and heat treating the manhole ring aluminum lithium plate. It is not known at this time whether this can be done in house or whether heat treating services will have to be procured. This will be further defined with the customer before proceeding

with the work. These items will be ordered in CY02 per customer's request, but will not be received or paid for until CY03 and therefore will not be estimated until CY03.

Subelement –CD: WBS was changed to 136905.08.04.01.08.08 per the customer's request. Reduced estimate due to work accomplished with fewer resources than originally estimated.

Subelement –CE: reduced estimate due to work accomplished with fewer resources than originally estimated.

Subelement –CI: reduced estimate due to work accomplished with fewer resources than originally estimated.

Subelement –CJ: reduced estimate due to work accomplished with fewer resources than originally estimated.

Subelement –CM: continued work from subelement -50 per the customer's request starting period 12. Estimate includes the remaining CY02 period (b)(4) (b)(4) The remaining work (b)(4) will not be received or paid for in CY02 and therefore will be estimated under this subelement in CY03.

Revision 03:
This revision increases scope by adding new personnel supporting the Constellation Exploration program as follows:

(b)(4)

This revision changes scope by adding a subelement for External Tank Metals work and also changes scope for several personnel who were supporting existing programs and will now support Constellation work:

- (b)(4) moving from Army Failure Analysis work to support the J2-X Engine program,
- (b)(4) moving from Army Failure Analysis work to support First Stage/RSRMV and Launch Abort System programs,
- (b)(4) reducing support to Solidification Science and Flight Experiments Projects to support Upper Stage,
- (b)(4) reducing support to Special Materials and Nuclear Power IRAD to support CLV Nuclear Power IRAD and Upper Stage friction stir weld pin tool development.

This revision also adjusted the estimate to account for work performed to date. This revision increases the cost of this task order by (b)(4) and involves modifications to Crew Launch Vehicle and/or Crew Exploration Vehicle tasks.

Revision 02:
The purpose of this revision is to add scope to hire a specialty subcontractor under subelement 50 to develop an industrial manufacturing flow plan for the Michoud Assembly Facility to accommodate manufacturing of the ARES I, ARES V and ORION spacecraft. This modification increases the cost of this task order by (b)(4) Funding for this task continues to be provided by PR 4200173425. **NOTE: This change does not involve any modifications to Crew Launch Vehicle or Crew Exploration Vehicle tasks.**

Revision 01:

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

This revision also captures Metals Engineering Branch work previously performed under task order 34-010003, “Materials Mechanical Test Facility Operations and Maintenance.” The metallic processes work previously performed under this task order has become subelement 02 in this task order. The work previously performed under 34-010003 has been carried over to the same subelement numbers as were used under the previous task.

The following subelements support the CLV WBS as follows:

Subelement	CLV WBS
34-030001-CA	136905.08.05.12.01.08
34-030001-CB	136905.08.05.12.02.08
34-030001-CD	136905.08.04.01.08.08

ESTS Contract Task Order Request Performance Plan

Task Order Title: EM30 Metals Engineering Division Support

Task Order Number: 34-030001 Revision: 16

Category	Weighting Technical %	End of Period Technical Score
Technical Objectives	65%	X 65% = 0.00
		Justification
Provide engineering and technical support to operate and maintain the Thermomechanical Processing Facilities, Materials Diagnostics Facility and the Process Development Team.		
	Weighting Schedule %	**Schedule Score**
Schedule Objectives (Milestones)	10% *(min 10%)*	X 10% = 0.00
		Justification
A majority of the work performed is real time and negotiated at the time of receipt. Quality records for the Electronic Work Request System database must be received within 10 calendar days from the date of actual completion.		
	Weighting Cost%	**Cost Score**
Cost (actual vs. negotiated)	25% *(min.25%)*	X 25% = 0.00
		Justification
	Weighting Total %	**Total Score**
	100.00%	**0.00**

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: EM30 Metals Engineering Division Support

Task Order Number: 34-030001 Revision: 16

Comments:

Marshall Space Flight Center
Engineering, Science & Technical Services

JACOBS ESTS Group

Risk Assessment

Contract Number: *NNM05AB50C*
TO Title: *EM30 Metals Engineering Division Support*
TO Number: *34-030001* **Revision:** *16*

Period of Performance: *10/02/2010* to *9/30/2011*

MSFC Initiator: *Tim Vaughn*

(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	2	1	There is a risk that the Task Order cost estimate will increase due to unanticipated overtime, material and ODC charges.
Risk C2	Cost			
Risk T1	Technical	1	1	No technical risks have been identified.
Risk T2	Technical			
Risk S1	Schedule	1	1	No schedule risks have been 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
4 Inevitable Occurrence (>95% Probability)	Y	Y	R	R
3 High Probability of Occurrence (>60% but <95% Probability)	G	Y	Y	R
2 Medium Probability of Occurrence (>25% but <60% Probability)	G	Y	Y	Y
1 Low Probability of Occurrence (<25% Probability)	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