

Task Order Plan (TOP)

Contract Number: NNM05AB50C

TO Title: *Impact and Penetration Analysis for Space Shuttle*

TO Number: 32-030201 **Revision:** 11

Period of Performance: 10/02/2010 to 2/28/2011

MSFC Initiator: Rod Stallworth

(b)(4)



Emergency: No

WBS# 197009.10.02.01.02

Subelement -SA

Revision 11:

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 February 28, 2011. Additionally, the Schedule, Performance Plan and Risk Assessment have been revised to reflect changes in task activities for the new period of performance. Subelement 00 was renamed Subelement SA to conform to the subelement naming convention. This revision affects the following Project: Space Shuttle.

Revision 10:

The purpose of this revision is to adjust the task estimates in subelement 00 Impact and Penetration Analysis for Space Shuttle due to redirection of resources in CY5 by the Task Initiator. There will be one less pre-flight simulation, three less post-flight simulations, and five less ice on Thermal Protection System (TPS) simulations than estimated. A total of (b)(4) were removed due to (b)(4) required for Task Order 32-030225-01 and (b)(4) hours required for Task Order 32-030227-01. Subcontractor costs were cut by (b)(4) due to hours redirected to Task Order 43-030004-01. The work load estimated for this task in CY6 remains unchanged. This revision affects the following Project: Space Shuttle.

Revision 09:

The purpose of this revision is to extend this task into Contract Year 5 of the NNM05AB50C ESTS contract. This revision defines and estimates work for the period October 3, 2009 through October 14, 2010. Additionally, the Schedule, Performance Plan and Risk Assessment have been revised to reflect changes in task activities for the new period of performance. (This TO is not part of Ares activities.) This revision affects the following Project: Space Shuttle.

Revision 08:

The purpose of this revision is to adjust the task estimates in subelement 00 Impact and Penetration Analysis for Space Shuttle due to redirection of resources by MSFC for the remainder of this contract year. A total of (b)(4) were cut. The work load for this task is expected to return in the new fiscal year.

Revision 07:

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 TO is not part of Ares activities.)

Revision 06:

The purpose of this revision is to adjust the task estimates in subelement 00 Impact and Penetration Analysis for Space Shuttle due to redirection of resources by MSFC for the remainder of this contract year. A total of (b)(4) Subcontractor cost, (b)(4) travel costs, and (b)(4) training costs were cut. The work load for this task is expected to return in the new fiscal year.

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.

Revision 04:

The purpose of this revision is to adjust the level of effort in subelement 00 Impact and Penetration Analysis for Space Shuttle due to redirection of resources by MSFC for the remainder of this contract year. Labor hours were increased by (b)(4) and subcontractor costs were decreased by (b)(4) from the estimates made in Revision 03.

Revision 03:

The purpose of this revision is to reduce the level of effort in subelement 00 Impact and Penetration Analysis for Space Shuttle, and to remove subelement 01 External Tank Gap Filler as Launch Debris Impact Analyses from this plan, both due to redirection of resources by MSFC. No charges have been made to subelement 01, and none will be made in this contract year. A total of (b)(4) and (b)(4) Subcontractor costs were cut from the estimates previously made in Revision 02.

WBS# 197009.10.02.01.02 Subelement -00
WBS# 843515.02.01.08.05.03 Subelement -CA

Revision 02:

The purpose of this revision is to extend subelement 00 Impact and Penetration Analysis for Space Shuttle, into Contract Year 2 of the NNM05AB50C ESTS contract. In addition, two subelements have been added to support meteoroid/orbital debris or launch debris assessments:

Subelement 01 External Tank Gap Filler as Launch Debris Impact Analyses, for additional work to support the External Tank (ET) project in an investigation of tile gap filler impacts on ET components through Contract Year 2; and

Subelement CA Crew Exploration Vehicle Composite Crew Module Meteoroid/Orbital Debris Impact Analyses, for additional work to support the NESC Composite Crew Module Pressure Vessel investigation through Contract Year 2.

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.

Revision 01:

This revision reflects changes in the estimated work hours due to NASA/MSFC realignment of tasks and delays of associated debris transport analysis (DTA) testing. A total of (b)(4) and (b)(4) Subcontractor cost were cut. The work load for this task is expected to return in the new fiscal year.

PR#: 4200157055

This Task Order (TO) replaces TO 22-030206 due to the NASA/MSFC reorganization and the subsequent realignment of the NNM05AB50C ESTS contract. This TP defines and estimates work for the period 1 April 2006 through 29 September 2006. Funding for this task is provided per MSFC PR # 4200157055. Additionally, the Schedule, Performance Plan and Risk Assessment have been revised to reflect changes in task activities for the new period of performance.

1.0 Task Order Description & Objectives

The objective of this task is to provide impact analysis support to the Space Shuttle Projects and state of the art spacecraft and vehicle systems development programs. Expert design and analyses will be provided in hydrocode modeling of low velocity impacts.

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Specific assignments include modeling of the External Tank thermal protection system (TPS) and to incorporate new TPS, ice, foam, and other launch debris materials models into SPHC, a smooth particle hydrocode written in C; and evaluation of available test data for code verification. Detailed reviews of pertinent drawings, necessary calculations, and code simulations will be performed. Finally, in support of debris transport analysis (DTA) SPHC will be used for impact simulations producing estimates of rebound velocities for various debris shapes, materials, and impact parameters on various launch pad and vehicle materials.

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

Required inputs will be developed as collaborative efforts with other members of each project team. It is assumed that the analysis inputs being developed by other members of each project will be available in a timely manner.

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Assessments will be accomplished by a combination of the following methods:

- Employ particle impact simulation software to assess local penetration/damage.
- Perform calculations regarding resistance to particle impact damage.
- Run comparisons with industry-wide particle impact databases.
- Hold discussions with design, stress, and materials personnel.

A specialist will be needed in impact and penetration analysis. This will include experience with running and interpreting analysis results of the codes. Office automation software will be utilized as appropriate to create the associated assessments and calculations. This software will include but not be limited to Microsoft Office (Word, Excel, and PowerPoint).

3.0 Discussion of Skills Required

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Personnel supporting this task must have knowledge of penetration mechanics of materials and experience running detailed SPHC models for a variety of materials.

4.0 Special Tools Required

Personnel performing this subtask must have experience running SPHC and producing reports and presentations adhering to the appropriate MSFC standards.

5.0 Participating Subcontractors

None.

6.0 Milestones & Deliverables

Monthly Activity Reports (MARs) are required via the Jacobs ESTS Integrator system. Final Report.

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

None.

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	2011					
			Oct	Nov	Dec	Jan	Feb	Mar
32-030201	SA	Impact and Penetration Analysis for Space Shuttle	[Gantt bar spanning Oct to Mar]					
32-030201	SA	SPHC Launch Debris Impact Assessments --Pre and Post-Flight	[Gantt bar spanning Oct to Mar]					
32-030201	SA	pre-flight simulations STS-133	[Gantt bar spanning Oct to Mar]					
32-030201	SA	<i>STS-133 Launch</i>	⑩ 11/1					
32-030201	SA	post-flight simulations STS-133	[Gantt bar spanning Oct to Mar]					
32-030201	SA	pre-flight simulations STS-134	[Gantt bar spanning Oct to Mar]					
32-030201	SA	<i>STS-134 Launch</i>	⑩ 2/26					
32-030201	SA	Ice on TPS Impact Simulations	[Gantt bar spanning Oct to Mar]					
32-030201	SA	pre-flight simulations STS-133	[Gantt bar spanning Oct to Mar]					
32-030201	SA	<i>STS-133 Launch</i>	⑩ 11/1					
32-030201	SA	post-flight simulations STS-133	[Gantt bar spanning Oct to Mar]					
32-030201	SA	pre-flight simulations STS-134	[Gantt bar spanning Oct to Mar]					
32-030201	SA	<i>STS-134 Launch</i>	⑩ 2/26					
32-030201	SA	Final Report	[Gantt bar spanning Oct to Mar]					
32-030201	SA	MARs and Year-End Report	[Gantt bar spanning Oct to Mar]					

ESTS Contract Task Order Request Performance Plan

Task Order Title: [Impact and Penetration Analysis for Space Shuttle](#)

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Category	Weighting Technical %	End of Period Technical Score
Technical Objectives	65%	X <u>65%</u> = Justification
This activity will examine the damage incurred by debris generated by the propulsion elements and Orbiter during the ascent profile. Multiple TPS types, ice, gap filler materials, launch pad debris and other debris sources as determined by the Space Shuttle program will be analyzed. An impact and penetration analysis specialist will be needed to understand the physics of all possible impacts in the higher velocity regimes. The specialist will be needed to review SPHC simulations results and run independent SPHC simulations. The specialist will also be called on to review SPHC material models and provide input to debris impact analysis teams.		
Schedule Objectives (Milestones)	Weighting Schedule % <u>10%</u> (min 10%)	Schedule Score X <u>10%</u> = Justification
Monthly activities will be reported at the end of each month.		
Cost (actual vs. negotiated)	Weighting Cost% <u>25%</u> (min.25%)	Cost Score X <u>25%</u> = Justification
	Weighting Total %	Total Score

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100.00%

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

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Comments:

Risk Assessment

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(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	1	No cost risks have been identified for this task.
Risk C2	Cost			
Risk T1	Technical	1	1	No technical risks have been identified for this task.
Risk T2	Technical			
Risk S1	Schedule	1	1	If required input data is not available on schedule, it may cause delays in associated deliverables.
Risk S2	Schedule			

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



