

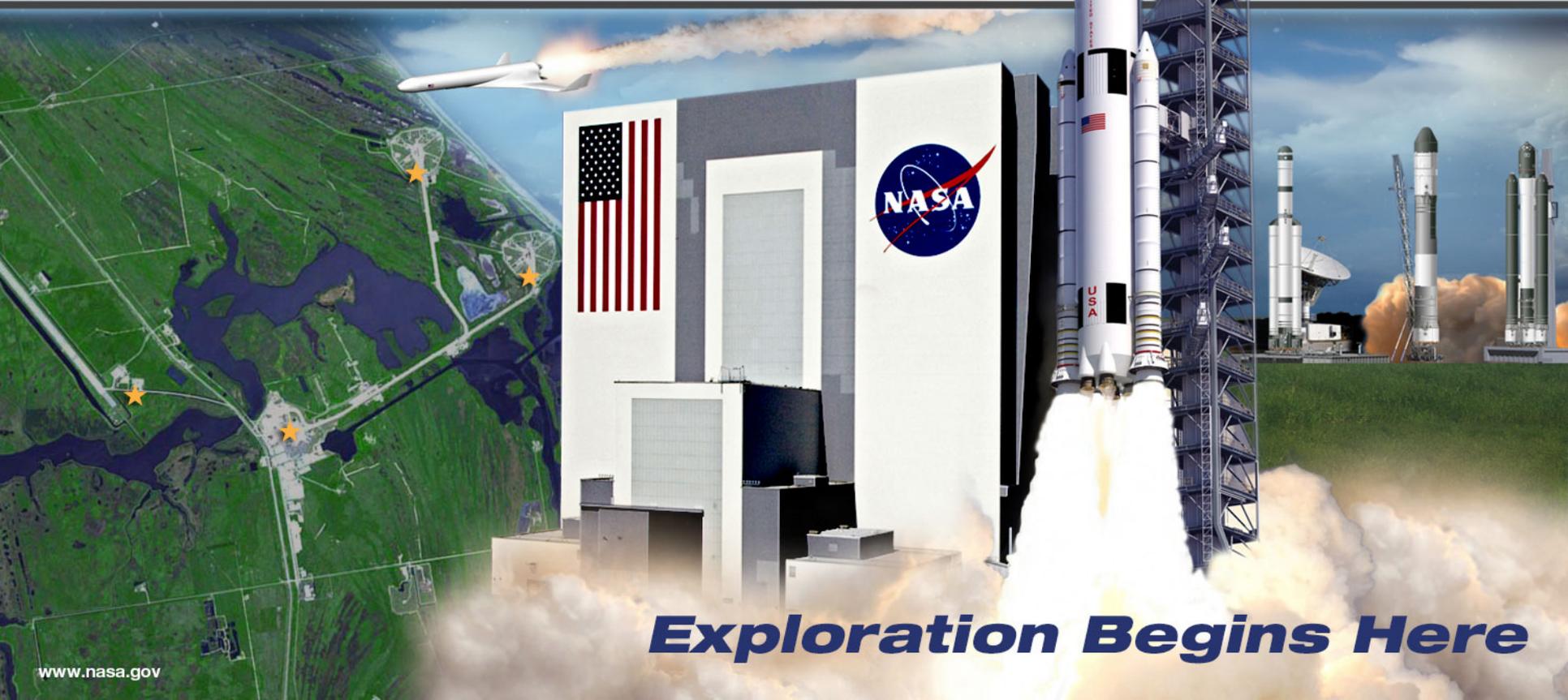


GSDO Lessons Learned from Implementing Cost and Schedule BOEs for a New NASA Program



2013 NASA Cost Analysis
Symposium
August 27-29, 2013

Dr. Howard S. Kanner, *LX*
John P. Biddix, *IRT*
NASA Kennedy Space Center



Exploration Begins Here

◆ **GSDO manages two development and modernization efforts at KSC (two different budget appropriations)**

- Exploration - Exploration Ground Systems (EGS)
- Space Ops - 21st Century Space Launch Complex (21CSLC)

◆ **EGS development focuses on SLS and Orion**

- Development of ground systems and operations plans and procedures to prepare, assemble, test, launch and recover Exploration elements
- Beyond-Earth Orbit (BEO) exploration
- GSDO follows NPR 7120.5 life cycle reviews for EGS Program content

◆ **21CSLC Initiative supports multi-use**

- Investments to repair, upgrade and modernize infrastructure to support multiple KSC users
- Commercial and government users
- 21CSLC is an initiative, therefore not subject to NPR 7120.5 life cycle reviews



GSDO Integrated Product Teams (IPTs)

Offline Processing and Infrastructure (OPI)

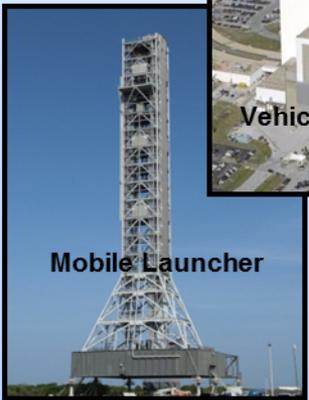
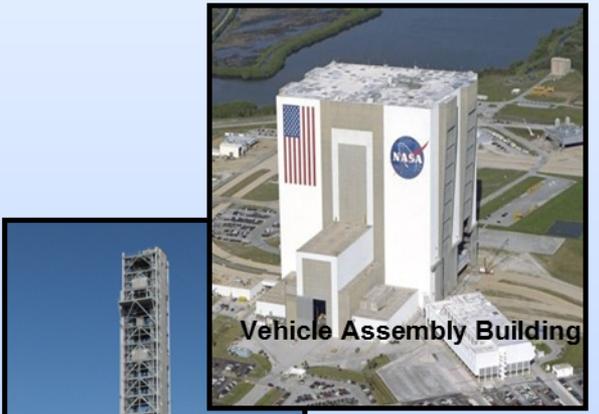


Command, Control, Communications & Range (C3R)



* 21CLSC

Vehicle Integration and Launch (VIL)



- ◆ **Coming out of SRR/SDR review, GSDO wanted to improve on BOEs**
 - Tasked Tiger Team to assess and improve both Cost and Schedule BOEs
 - Basis of Estimates required per
 - NPR 7120.5E
 - HEOMD Program Requirement Guidance (PRG)
- ◆ **Goal: Document GSDO Basis of Estimates to meet both PPBE15 Submit and Preliminary Design Review (PDR) requirements**
 - Strategy:
 - Develop desktop instructions to define content requirements and expectations
 - Developed requirements and expectations with IPAQ/SRB PAG
 - Standardize cost and schedule BOE input templates
 - Presented templates and process at February 2013 ECASG
 - Train BOE content owners on requirements and expectations
 - Inform management throughout process
 - Validate BOEs against GAO/SRB Criteria
 - Validate BOEs against financial database and program schedule
 - Divide cost and schedule effort

- ◆ **SRR/SDR BOEs submitted in Microsoft Word, PowerPoint and Excel**
 - Need common template to accommodate multiple styles of BOEs
 - Template should not be more complicated than previous styles
 - Template should allow data to easily be extracted due to large number of BOEs required
- ◆ **BOEs needs to meet GAO, Agency and Program requirements**
- ◆ **Where do you find BOE template that meets all these requirements?**
 - Searched KSC and NASA databases, reviewed other program's approaches
 - Searched Internet for non-NASA solutions
 - Due to time constraints, only viable option was to quickly develop BOE templates
 - Started with simple MS Excel format and then added lot of really cool macros
 - Data validation flags, Last-Saved-By flag, automated filename generation
 - Automated report generation with costs, head counts and scorecard
 - Validation of phased cost and head count data with financial database
 - Excel-searchable tool for financial database content
 - Dynamic tracking list of WBS submittals vs. required
 - Incorporated GAO assessment criteria into template design

◆ **GSDO Organization Structure**

- Program Management and 3 IPTs (VIL, OPI, C3R)

◆ **2579 WBS in GSDO WBS Dictionary**

◆ **328 Cost BOEs submitted**

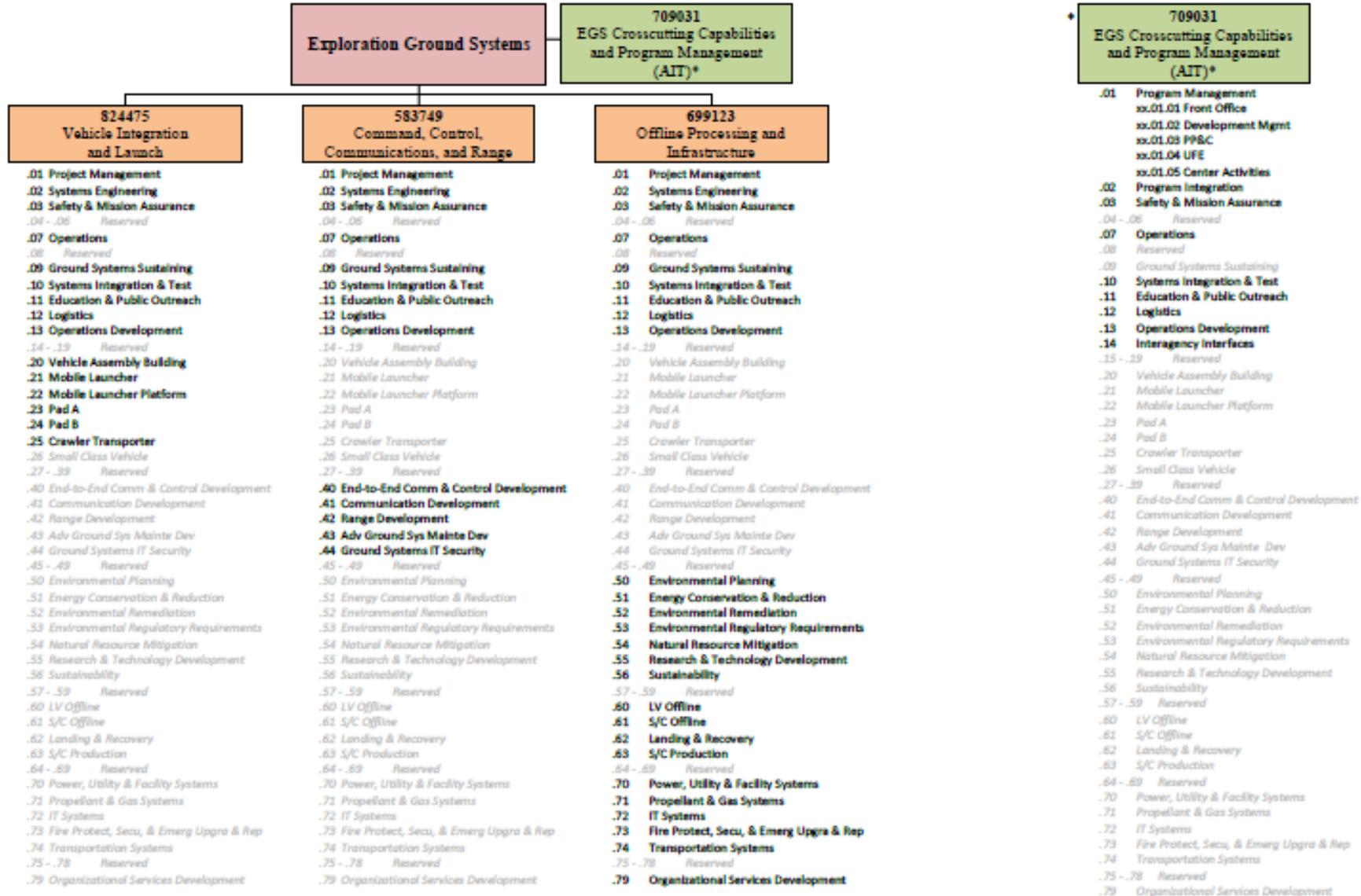
- Content for 1 WBS (“Single”) – One BOE and one WBS
- Content partially defining 1 WBS (“Split”) - More than one BOE for WBS
- Content defining multiple WBS (“Merged”) - More than one WBS on BOE

◆ **55 Schedule BOEs submitted**

- Single, Split and Merged content, as above
- Developed at subsystem level only



Ground Systems Development and Operations - Program Plan
Baseline



◆ Header

- WBS Title, WBS, Project Manager, BOE POC, IPT

◆ Time Phasing of Budget

- Cost breakdown by year and cost category (FTE, WYE, ODC, CoF, Travel, FP&D)

◆ WBS Scope Description:

- Describe the scope (Who, what, how, where and when?)

◆ Cost Basis of Estimate

- How did you derive the cost? (Did you use analogous or bottom up estimation methodology)
- Show calculations in the "PM Work Area" below Red Line.

◆ Risks and Opportunities:

- List any areas of the cost estimates containing significant risk or opportunity should be identified - (from ARM) - is it included in the estimate?

◆ Assumptions:

- List your cost estimate assumptions here.

◆ Contingency:

- Identify Contingency



Cost BOE Template - Interactive Fields

COST BASIS OF ESTIMATE PPBE15 - SUMMARY										
vvvv DO NOT CHANGE FORMATTING WHEN THESE LINES vvvvv										
WBS Title:	Cost BOE Example Title									
WBS:	000000.00.00									Green
Project Manager:										Red
BOE POC:										
IPT:	Choose									
Appropriation Source:	EGS									
Base Filename:	BOEc_Choose_WBS_000000-00-00_	usrtxt	.xlsm							SaveAs
Time Phasing of Budget (\$K), WYEs, and FTEs (FY2014 through FY2019): Provide Time Phasing Cost (Cumulative for all Orgs). If breakdown by organization is required, please use "PM Work Area" below Red Line. The costs are phased below for the total FTE and WYE labor and ODC associated with this activity										
										Green
	000000.00.00	FY14	FY15	FY16	FY17	FY18	FY19			Total
	FTE Labor Costs (\$K)	\$ 300.000	\$ 300.000	\$ 450.000	\$ 600.000	\$ 300.000	\$ 300.000			\$ 2,250.000
	WYE Labor Costs (\$K)	\$ 400.000	\$ 533.333	\$ 800.000	\$ 800.000	\$ 400.000	\$ 266.667			\$ 3,200.000
	NASA ODC Costs (\$K)	\$ 314.159	\$ 628.318	\$ 157.080						\$ 1,099.557
	WYE ODC Costs (\$K)									\$ -
	CoF Costs (\$K)	\$ -								\$ -
	FP&D Costs (\$K)	\$ -								\$ -
	Travel Costs (\$K)	\$ -								\$ -
	TOTAL By FY (\$K)	\$ 1,014.159	\$ 1,461.651	\$ 1,407.080	\$ 1,400.000	\$ 700.000	\$ 566.667			\$ 6,549.557
	FTE	2	2	3	4	2	2			15
	WYE	3	4	6	6	3	2			24

Colors change when data entered

Save As function standardizes files



Cost BOE Template – Self-Assessment

PPBE15 - SUMMARY			Criteria Satisfied	Category	Additional Info																																	
BETWEEN THESE LINES vvvvv																																						
<table border="1" style="width: 100%;"> <tr> <th colspan="2">LEGEND</th> </tr> <tr> <td>ENTRY DESCRIPTOR</td> <td></td> </tr> <tr> <td style="background-color: yellow;">USER INPUT</td> <td style="background-color: orange;">INVALID USER ENTRY</td> </tr> <tr> <td>ADDITIONAL INFO</td> <td style="background-color: lightblue;">FORMULA CALCULATION</td> </tr> </table>			LEGEND		ENTRY DESCRIPTOR		USER INPUT	INVALID USER ENTRY	ADDITIONAL INFO	FORMULA CALCULATION	Green	1. Existence of Formal BOE	Well documented	BOE Reviewer Comments																								
LEGEND																																						
ENTRY DESCRIPTOR																																						
USER INPUT	INVALID USER ENTRY																																					
ADDITIONAL INFO	FORMULA CALCULATION																																					
			Red	2. Estimate is Traceable	Well documented																																	
Choose_WBS_000000-00-00_			usrtxt	.xlsm	SaveAs																																	
				Time Phasing of Budget																																		
Please use "PM Work Area" below Red Line.				This should match PPBE15 inputs for each WBS and match the schedule																																		
activity				2. Estimate is Traceable	Well documented	BOE Reviewer Comments																																
				3. Basis is Traceable	Well documented																																	
				4. Repeatable	Well documented																																	
				5. Error Free	Accurate																																	
				9. Time Phasing	Credible																																	
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<table border="1" style="width: 100%;"> <thead> <tr> <th>FY17</th> <th>FY18</th> <th>FY19</th> </tr> </thead> <tbody> <tr> <td>\$ 600.000</td> <td>\$ 300.000</td> <td>\$ 300.000</td> </tr> <tr> <td>\$ 800.000</td> <td>\$ 400.000</td> <td>\$ 266.667</td> </tr> <tr> <td></td> <td></td> <td></td> </tr> <tr> <td>\$ 1,400.000</td> <td>\$ 700.000</td> <td>\$ 566.667</td> </tr> <tr> <td>4</td> <td>2</td> <td>2</td> </tr> <tr> <td>6</td> <td>3</td> <td>2</td> </tr> </tbody> </table>			FY17	FY18	FY19	\$ 600.000	\$ 300.000	\$ 300.000	\$ 800.000	\$ 400.000	\$ 266.667																\$ 1,400.000	\$ 700.000	\$ 566.667	4	2	2	6	3	2			
FY17	FY18	FY19																																				
\$ 600.000	\$ 300.000	\$ 300.000																																				
\$ 800.000	\$ 400.000	\$ 266.667																																				
\$ 1,400.000	\$ 700.000	\$ 566.667																																				
4	2	2																																				
6	3	2																																				

Color changes to green when calcs add up correctly

Drop Down assessment scale



Cost BOE Template - GAO/SRB Criteria

Add Score Tools	** IAT USE ONLY **											
	SCORECARD				** IAT USE ONLY **							
GAO/SRB Criteria	1	2	3	4	5	6	7	8	9	10	11	12
	Well Documented				Comprehensive		Accurate		Credible			
	Existence of Formal BOE	Estimate is Traceable	Basis is Traceable	Repeatable	Complete Scope	Completeness	Calculations Error Free	Tools/Stats Applied Properly	Time Phasing	Realism	Estimating Uncertainty	Discrete Risks
Header	Green	Red										
Time Phasing of Budget									Green			
Total Estimated Cost												
WBS Scope Description					Green							
Cost Basis of Estimate		Green	Green						Green			
Risks and Opportunities			Green							Yellow		
Assumptions and Exclusions						Yellow						
Contingencies												

Assessment scores for entire BOE



Cost BOE Summary Reports

Automated Report Generation

Color-Coded data comparison with tolerance bands

Compile Cost BOEs		Extract Submit Cost Data		startrow	7	Add WBS Split Row	FY14-FY19 Program Budget (\$K)								
				Colorindex	33						\$ 250,000.000				
											Sub Total	Sub Total	Sub Total	Sub Total	Sub Total
				23							46,771.216	58.71%	\$ 146,771.217	\$ 0.001	0.00%
WBS	WBS Title	IPT	Appropri	FY14	FY15	FY16	FY17	FY18	FY19	Sub Total (\$K)	% Budget	Submit Total (\$)	Delta (Subm	Delta	O
123456.01.01.11	Front Office Mgmt./Admin	A-Team	EGS	\$ 1,326.744	\$ 153.875	\$ 1,271.445	\$ 1,335.373	\$ 1,335.373	\$ 1,335.373	\$ 5,427.791	2.11%	\$ 5,279.791	\$ 0.000	0.00%	
123456.01.02.11.01	Project Support	A-Team	EGS	\$ 4,596.974	\$ 1,832.332	\$ 1,333.175	\$ 2,007.072	\$ 2,007.072	\$ 2,007.072	\$ 11,868.507	4.75%	\$ 11,868.506	\$ (0.001)	0.00%	
123456.01.02.11.02.01	Business Resource Management	A-Team	EGS	\$ 517.092	\$ 540.813	\$ 438.164	\$ 607	\$ 607	\$ 607	\$ 2,568.705	1.03%	\$ 2,568.705	\$ 0.002	0.00%	
123456.01.02.11.02.02	Contract Management	A-Team	EGS	\$ 11.272	\$ 10.609	\$ -	\$ -	\$ -	\$ -	\$ 21.880	0.01%	\$ 21.880	\$ -	0.00%	
123456.01.02.11.02.03	Electrical	A-Team	EGS	\$ 286.274	\$ 298.040	\$ 168.558	\$ 837	\$ 32.750	\$ 32.750	\$ 942.259	0.38%	\$ 942.259	\$ -	0.00%	
123456.01.03.01.11	PP&C Business	A-Team	EGS	\$ 2,700.205	\$ 775.664	\$ 2,317.227	\$ 162	\$ 1,040.311	\$ 1,040.311	\$ 8,916.569	3.57%	\$ 8,916.569	\$ -	0.00%	
123456.07.04.04.11	Safety	A-Team	EGS	\$ 226.583	\$ 2,037.179	\$ -	\$ 617.898	\$ 35.002	\$ 35.002	\$ 5,533.794	2.21%	\$ 5,533.794	\$ -	0.00%	
123456.07.04.05.11	Labs	A-Team	EGS	\$ 907.106	\$ 5.334	\$ -	\$ 466.176	\$ 887.940	\$ 887.940	\$ 2,767.567	1.11%	\$ 2,767.567	\$ -	0.00%	
123456.07.07.11	Work Control	A-Team	EGS	\$ 2,948.858	\$ 8	\$ -	\$ 2,265.570	\$ 3,868.647	\$ 3,868.647	\$ 12,503.819	5.00%	\$ 12,503.819	\$ -	0.00%	
123456.10.01.11	SI&T Planning	A-Team	EGS	\$ 693.788	\$ 6	\$ 529.273	\$ 212.269	\$ 544.828	\$ 544.828	\$ 2,673.743	1.07%	\$ 2,673.743	\$ -	0.00%	
123456.11.11	EPO	A-Team	EGS	\$ 164.4	\$ -	\$ 168.341	\$ 84.585	\$ 75.827	\$ 75.827	\$ 516.738	0.21%	\$ 516.738	\$ -	0.00%	
123456.12.11.01	Logistics Management and Integration	A-Team	EGS	\$ 383.3	\$ 0.807	\$ 166.571	\$ 416.099	\$ 37.874	\$ 37.874	\$ 1,114.683	0.45%	\$ 1,114.683	\$ -	0.00%	
123456.12.11.02.01	Propellants and Commodities	A-Team	EGS	\$ 1,281.2	\$ 1.118	\$ 13,327.374	\$ 96.039	\$ 2,413.737	\$ 2,413.737	\$ 18,379.633	7.35%	\$ 18,379.633	\$ -	0.00%	
123456.12.11.02.02	Propellant and Life Support O&M	A-Team	EGS	\$ -	\$ 3,078.540	\$ 3,787.282	\$ 7,017.176	\$ 7,230.245	\$ 7,230.245	\$ 26,327.681	10.53%	\$ 26,327.681	\$ -	0.00%	
123456.12.11.03	Material Management	A-Team	EGS	\$ -	\$ 6,316.998	\$ 15,380.984	\$ 4,868.506	\$ 6,519.392	\$ 6,519.392	\$ 34,297.124	13.72%	\$ 34,297.124	\$ -	0.00%	
123456.12.11.04	Logistics Engineering	A-Team	EGS	\$ 11.333	\$ 398.014	\$ 163.892	\$ 693.051	\$ 1,000.230	\$ 1,000.230	\$ 2,266.521	0.91%	\$ 2,266.521	\$ -	0.00%	
123456.12.11.05.01-SPLT	Depot LES	A-Team	EGS	\$ 2,312.325	\$ 1,941.532	\$ 94.661	\$ 498.995	\$ 2,717.257	\$ 2,717.257	\$ 7,564.770	3.03%	\$ -	\$ -		
123456.12.11.05.01-SPLT	Facility O&M LES	A-Team	EGS	\$ 91.562	\$ 354.835	\$ 345.357	\$ 37.925	\$ 125.055	\$ 125.055	\$ 954.733	0.38%	\$ -	\$ -		
123456.12.11.05.01	FROM SPLIT	A-Team	EGS	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ 8,519.503	\$ -	0.00%	
123456.12.11.05.02	Facility O&M Contractor Road	A-Team	EGS	\$ 169.326	\$ 427.983	\$ 218.148	\$ 128.539	\$ 102.811	\$ 102.811	\$ 1,046.806	0.42%	\$ 1,046.806	\$ -	0.00%	
123456.12.11.05.04	Logistics Heavy Equipment	A-Team	EGS	\$ 13.881	\$ 42.951	\$ 101.100	\$ 50.477	\$ 114.148	\$ 114.148	\$ 322.557	0.13%	\$ 322.557	\$ -	0.00%	
123456.12.11.05.05	Logistics Facility Custodial Services	A-Team	EGS	\$ 58.602	\$ 56.999	\$ 101.870	\$ 142.054	\$ 42.137	\$ 42.137	\$ 401.662	0.16%	\$ 401.662	\$ -	0.00%	
123456.12.11.08.01	L&R Recovery Assets	A-Team	EGS	\$ 286.405	\$ 9.524	\$ 46.011	\$ 8.836	\$ 150.900	\$ 150.900	\$ 501.676	0.20%	\$ 501.676	\$ -	0.00%	
												\$ -	\$ -		

Ability to Roll up multiple BOEs to a single WBS



◆ Header

- Schedule Baseline Date, WBS Title, WBS, Project Manager, BOE POC, IPT

◆ WBS Scope Description:

- Describe the scope (Who, what, how, where and when?) - Provide key-dates and Milestones

◆ Schedule Basis/Planning Strategy:

- How did you determine the schedule? (Did you use analogous or bottom up estimation methodology), List any contractor schedules used for to develop your schedule estimate.
- Show calculations in the "PM Work Area" below Red Line.

◆ Risks and Opportunities:

- List any areas of the schedule estimates containing significant risk or opportunity should be identified - (from ARM) - is it included in the estimate?

◆ Assumptions:

- List your schedule assumptions here.

◆ Schedule Reserve / Contingency:

- Identify Schedule Reserve / Contingency in the schedule (Note: Schedule Reserve / Contingency is not intended to cover changes in scope).

◆ Provide snapshot of schedule. Detailed schedule will also need to be provided as back up.

Schedule BOE Template - Interactive Fields

Symposium BOE Templates.xlsm

SCHEDULE BASIS OF ESTIMATE PRBE15													Criteria Satisfied			
www DO NOT CHANGE FORMATTING BETWEEN www																
Schedule Baseline Date or Version:			01/01/2001													
WBS Title:			Schedule BOE for Cost BOE Example Title			LEGEND			Green		1. Existence of Formal BOE					
WBS:			123456.01.02.11			DESCRIPTOR			Red		2. Estimate is Traceable					
Project Manager:						USER INPUT			INVALID USER ENTRY							
BOE POC:						ADDITIONAL INFO			FORMULA CALCULATION							
IPT			AIT													
Base Filename:			BOEs_AIT_WBS_123456-01-02-11_			usrtxt		.xlsm		SaveAs						
WBS Scope Description:																
Describe the scope (Who, what, how, where and when?) - Provide key-dates and Milestones																
This activity is for the design, build, test and installation of a widget. The requirements flow in from FY13, with 30 and 60% design reviews and PDR in FY14, including simulation generation, requiring ODC for the acquisition of analysis software and model fabrication. FY15 includes verification testing and culminates with the 90% design review and CDR. FY16 includes the integration and validation efforts, leading to FY17 activities of supporting implementation for EM-1 launch. Post launch and WYE labor perform analyses and widget assessment to incorporate lessons-learned for EM-2 preparations.													Green		2. Schedule Estimate is Traceable	
													Green		3. Completeness	
															5. Realism	
Schedule Basis/Planning Strategy:																
How did you determine the schedule? (Did you use analogous or bottom up estimation methodology), List analog estimator schedules used for to develop your schedule estimate. Show calculations in the "PM Work Area" below Red Line.																
Labor estimates are based upon a bottoms-up analysis assuming single-shift, with details in workspace below. The hardware model development and build will be performed in-house with schedules provided by the institutional organization. The verification, validation and integration schedules were based upon A&E contract NCC-1701.													Green		2. Schedule Estimate is Traceable	
															4. Calculations Error Free	
															5. Realism	

Cost_BOE Cost Evaluation Key Schedule_BOE Schedule Evaluation Key Cost_COMPLETE

Colors change when data entered

Save As function standardizes files

Self-assessment against SRB/GAO Criteria

BOE Template includes Evaluation Criteria



- ◆ **Establish clearly defined process which includes: level of content details, funding sources (i.e. appropriations), WBS Level, etc.**
 - GSDO has multiple appropriation sources (EGS, 21st Century, etc.)
- ◆ **Management must set deadlines and stick to them – develop clear defined goals – prevent process from becoming overcome by events**
- ◆ **Define Roles and Responsibilities of management, BOE content owners and internal reviewers**
 - Who should be responsible for developing the BOEs (PP&C, Technical Management, etc.)
 - Establish single point of contact for BOEs in each Program element
 - Require estimating training for BOE authors before budget cycle and BOE development
 - Develop BOE review teams which include management
- ◆ **Maintain open communication with Program elements, management and POCs with frequent meetings to address burn-down towards completion, issues, etc.**



◆ Standardize and document process

- Do not change during process, but establish a plan to address unique inputs
- Document process includes grading criteria, grading process and rework process
 - Clear definition of when BOE good enough (adequate, but not perfect)
- Establish process for SBU or Procurement sensitive BOEs

◆ Identify standard verbiage where applicable

- How do you address LOE activity, FTEs (Civil Servants), etc.
- How do you address BOEs when including management challenges and budget constraints

◆ Establish one repository for all BOEs

- Require access control and version control with update logs

◆ Document Lessons Learned



◆ **Schedule BOEs new requirement (Pathfinder)**

- GSDO team never created similar products before (waived for SRR/SDR)
- Work-In-Progress: continue to mature based upon stakeholder feedback

◆ **Scope tie-in to Cost**

- Difficult to perceive cost and schedule BOEs as separate – like Siamese twins
- Schedule BOE expected to define time frame over which Costs phased

◆ **Per OMB direction, initial development of GSDO WBS format created large WBS dictionary that “defines the scope of work and parses it into a logical, hierarchical structure for planning management.”**

- Many unused WBS, and requires continuous housekeeping
- When setting up WBS, sometimes less is better
 - Define for future uses (EVM, Cost-Schedule mapping, JCL Development, etc.)

If you would like a copy of templates or more information, please contact:

- ◆ **John P. Biddix, Independent Review Team (IRT)**
 - John.P.Biddix@nasa.gov
- ◆ **Dr. Howard S. Kanner, GSDO LX**
 - Howard.S.Kanner@nasa.gov



PDR - BOE Assessment Criteria

	Criteria	Green	Yellow	Red	
Existence of Formal BOE	Cost/budget/schedule are documented with a formal BOE	A formal BOE exists that is "current"	No formal BOE but data exists or "outdated" BOE	No formal BOE or data delivered	Objective
Estimate is Traceable	Cost and Schedule estimates trace from BOE to the budget.	BOE tracks to Budget/Estimate within acceptable rounding errors (ruddy traceable - 1 000s, techniques, estimating methodology, and supporting data used to develop the estimate is	BOE tracks to Budget/Estimate within 10%	BOE does not track to Budget/Estimate	Objective
Basis is Traceable	The estimating methodology and rationale is provided and the information is presented in a traceable manner containing all supporting source documentation and technical data. Changes from previous estimates are tracked.		Partially traceable - Methodology provided but lacks supporting details	Not traceable - No Basis for calculations provided.	Objective
Repeatable	Cost/budget/schedule estimates can be replicated by personnel from an outside agency or replacement personnel.	The estimate can be replicated within acceptable rounding errors.	Part of the estimate can be replicated	Not enough information is provided to replicate the estimate.	Objective
Comprehensive					
Scope	Well defined scope/baseline	Fully defined technical baseline/scope of effort	Partially defined technical baseline/scope, lacks details such as quantities and specific descriptions that include mass, dimensions, and power requirements as appropriate.	Undefined technical baseline / scope	Objective
Completeness	All ground rules, assumptions, rationale, and exclusions are included	All ground rules, assumptions, rationale, exclusions provided	Partial ground rules, assumptions, rationale, exclusions provided	No ground rules, assumptions, rationale, exclusions provided	Objective
Accurate					
Error Free	Calculations are Error Free	Calculations are totally error free	Minor calculation error(s) without impacting outcome/plan	Significant calculation errors exist or not enough information is provided to evaluate	Objective
Applied Properly	Estimating Methodology / Statistics Applied Properly	Estimating methodology and/or statistics are applied correctly.	Improperly applied estimating methodology / statistics without impacting outcome	Improperly applied statistics/methodology impacting outcome or not enough information is provided to evaluate	Objective
Credible					
Time Phasing	Is estimate phasing explained and consistent with IMS	Estimate is phased, rationale for time phasing provided, and phasing is consistent with IMS	Limited rationale for time phasing and/or inconsistent with IMS	No rationale for time phasing	Objective
Realism	Sound/Realistic/Executable - Judgments or rationale well justified. Appropriate analogies, CERs, SERs applied, data points are not "cherry picked" to bias results. Realistic assumptions.	Methodology and rationale are well justified and source data supports the estimate. If applicable, UFE/reserves are expected to cover all known and unknown risks.	Methodology and rationale are partially justified. Estimating methodology and/or source data lacks applicability. If applicable, UFE/reserves appear low.	Methodology and rationale not justified and/or not consistent with historical experience. No source data supporting estimate was provided. If applicable, UFE/reserve calculations not performed or extremely low.	Subjective
Discrete Risks	Discrete Risk Analysis of the project's risk list is used to inform the level of UFE/contingency/reserves/margin	Risk list is quantitatively assessed (i.e., expected value, or simulation) and linked to level of UFE / reserve / contingency / margin	Portion of risk list is assessed and applied or the discrete risks are not linked to the level of UFE/reserves	Risk list is not applied or linked to level of UFE/reserves	Objective: Risk list is not applied or linked to level of UFE/reserves Subjective: Quasi-Objective: Uncertainty can be less detailed at milestones (SRP) and more detailed at later milestones. A basis for estimating likelihood, consequence of discrete risks should be provided. A basis for UFE/margins/reserves tied to the risks should be provided. Basis may be explained at a macro level or individual WBS level. May not be applicable to a WBS element
Estimating Uncertainty	Estimating Uncertainty is used to inform the level of UFE/contingency/reserves/margin	Uncertainty is quantitatively assessed (expected value, simulation, S-curve) and linked to the level of UFE/reserve/contingency/margin	Uncertainty is partially applied to some elements and/or not linked to the level of UFE/reserve/contingency/margin	Uncertainty is not applied or linked to the level of UFE/reserves	Objective: Uncertainty can be less detailed at milestones (SRP) and more detailed at later milestones. A basis for estimating uncertainties should be provided. Basis for UFE/margins/reserves tied to uncertainty should be provided. Basis may be explained at a macro level or individual WBS level. May not be applicable to a WBS element

Cost BOE Assessment Criteria

GAO Criteria	BOE Assessment Criteria	Definition	GSDO Goal
Well Documented	Existence of Formal BOE	Cost/budget documented with formal BOE	“Current”- We must have a BOE for Cost
	Estimate Sums	Cost estimates add up from BOE and <u>equal</u> PPBE-15 Submit	Acceptable rounding errors only
	Basis is Traceable	If back up detail requested, it will support estimate and match calculations	Fully traceable (tools, techniques, estimating methodology, and supporting data used to develop estimate provided)
	Repeatable	If someone repeated BOE calculations, they get same total. Must show math.	Estimate can be replicated within acceptable rounding errors
Comprehensive	Scope	Scope needs to define who, what, where, when and how work being performed for WBS	Fully defined technical baseline/ scope of effort
	Completeness	All ground rules, assumptions, rationale, and exclusions included	Well documented, good understanding of estimators rationale

Cost BOE Assessment Criteria

GAO Criteria	BOE Assessment Criteria	Definition	GSDO Goal
Accurate	Error Free	<p>Calculations are error free -</p> <ul style="list-style-type: none"> • Calculations on Cost BOE must be error free • BOE Cost vs. PPBE-15 Submit must be equal • BOE Cost data must match data in detailed backup 	Rounding errors only
Credible	Time Phasing	Estimate time phasing explained and consistent with IMS. Make sure explanation for cost and schedule are consistent.	Estimate phased, rationale for time phasing provided, phasing consistent with IMS
	Discrete Risks	List risks that affect PPBE submit	Risk list quantitatively assessed and linked to level of UFE (reserve/contingency/margin)
	Estimating Uncertainty	In most cases, UFE is what remains after allocation and not set percentage	Uncertainty quantitatively assessed and linked to level of UFE (reserve/contingency/margin)
	Realism	Does Basis of Estimate make sense? Could outside reviewer grasp rationale behind estimate? Does detailed back up support estimate?	Methodology and rationale well justified and source data supports estimate. If applicable, UFE (reserves) expected to cover all known and unknown risks

Schedule BOE Assessment Criteria

GAO Criteria	BOE Assessment Criteria	Definition	GSDO Goal
Well Documented	Existence of Formal BOE	Schedule estimate methodology and assumptions documented with formal BOE	“Current” - Must have BOE for Schedule PPBE15 content
Traceable	Schedule Estimate Traceable	If back up detail requested, it will support estimate and match calculations	Fully traceable (tools, techniques, estimating methodology, and supporting data used to develop schedule estimate provided)
Comprehensive	Completeness	All ground rules, assumptions, rationale, and exclusions included	Well documented, good understanding of estimators rationale
Accurate	Calculations Error Free	Calculations error free - • Calculations on Schedule BOE must be error free	Rounding errors only... Calculations for schedule estimation shown need to be accurate and complete
Credible	Realism	Does Basis of Estimate make sense? Could outside reviewer grasp rationale behind estimate? Does detail back up support estimate?	Sound methodology and defensible rationale. Source data supports estimate. Schedule is executable and has reserves as needed to cover all known and unknown risks.

Table 11: Three Cost Estimating Methods Compared

Method	Strength	Weakness	Application
Analogy	<ul style="list-style-type: none"> ■ Requires few data ■ Based on actual data ■ Reasonably quick ■ Good audit trail 	<ul style="list-style-type: none"> ■ Subjective adjustments ■ Accuracy depends on similarity of items ■ Difficult to assess effect of design change ■ Blind to cost drivers 	<ul style="list-style-type: none"> ■ When few data are available ■ Rough-order-of-magnitude estimate ■ Cross-check
Engineering build-up	<ul style="list-style-type: none"> ■ Easily audited ■ Sensitive to labor rates ■ Tracks vendor quotes ■ Time honored 	<ul style="list-style-type: none"> ■ Requires detailed design ■ Slow and laborious ■ Cumbersome 	<ul style="list-style-type: none"> ■ Production estimating ■ Software development ■ Negotiations
Parametric	<ul style="list-style-type: none"> ■ Reasonably quick ■ Encourages discipline ■ Good audit trail ■ Objective, little bias ■ Cost driver visibility ■ Incorporates real-world effects (funding, technical, risk) 	<ul style="list-style-type: none"> ■ Lacks detail ■ Model investment ■ Cultural barriers ■ Need to understand model's behavior 	<ul style="list-style-type: none"> ■ Budgetary estimates ■ Design-to-cost trade studies ■ Cross-check ■ Baseline estimate ■ Cost goal allocations

Source: © 2003, MCR, LLC, "Cost Estimating: The Starting Point of EVM."