Falcon 9 Launch Vehicle NAFCOM Cost Estimates

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NASA Associate Deputy Administrator for Policy

Falcon 9 Launch Vehicle NAFCOM Cost Estimate

- The objective of the analysis was to estimate the cost to develop the Falcon 9 launch vehicle using two different approaches: 1) traditional NASA environment/culture, and 2) a more commercial development culture approach.
- The analysis was performed late 2010-early 2011 using the NASA-Air Force Cost Model (NAFCOM) with results provided to ESMD in November 2010.
- These results were used for Appendix B of the "Commercial Market Assessment for Crew and Cargo Systems" and for the Deputy Administrator's presentation at the National Space Symposium.
- Results: "The activity estimated Falcon 9 would cost $3.977B based on NASA environment/culture. NAFCOM predicted $1.695B when all technical inputs were adjusted to a more commercial development approach.
- Working with different inputs from the preliminary data provided by SpaceX after a trip to the SpaceX facility, NASA recently inputted revised data into the NAFCOM model and a different output was the result.

Original Cost Estimates versus SpaceX Actuals

- NASA did not perform a detailed analysis to explain the significant differences between the cost estimates and SpaceX actual costs.
- However, SpaceX attributed their cost efficiencies to a few primary factors.

  1. Workforce - Total vehicle DDT&E costs are primarily a product of the total workforce needed to accomplish the effort (SpaceX workforce numbers substantiate their development cost claims),

  2. Organizational complexity – SpaceX estimates that every dollar sent out of the company actually costs between $3 and $5 based on subcontractor overhead and profit, and

  3. Infrastructure - Total infrastructure required for the DDT&E effort and infrastructure utilization percentage.

  These factors suggest that reducing the total workforce; number of management layers and infrastructure can substantially reduce DDT&E costs when compared to traditional NASA environment/culture.

Update to the Cost Estimates

- The original estimates were based on technical parameters and inputs supplied by SpaceX in the fall of 2010.
    - Provided only a Cost Plus Fee approach
    - Included a single first flight unit
- NASA personnel subsequently visited the Space X facilities and spoke with SpaceX personnel about the inputs and results of the initial modeling effort.
    - The updated estimates provided both Cost Plus Fee and Firm Fixed Price approaches and included two flight unites
- The initial and updated cost estimates are not NASA budget estimates.
    - Do not include all costs that would be included in a NASA project budget
    - Are schedule and time phasing independent
- Both the initial and updated cost estimates are included in this presentation.

Falcon 9 Cost Estimates Trace

Falcon 9 NAFCOM Cost Estimate Comparison (All Costs Are In FY2010 $M)					
	Initial Estimate			Updated Estimate	
	Cost Plus Fee	Cost Plus Fee		Firm Fixed Price	Cost Plus Fee
	Total	Total		Total	Total
Elements	(FY2010 $M)	(FY2010 $M)		(FY2010 $M)	(FY2010 $M)
Falcon 9 Total	$1,695	$3,977		$443	$1,383

Assumptions inserted after Space-X visit:

- More heritage from Falcon 1 and use of off-the-shelf hardware than the initial information
- Nine redundant controllers and wiring harnesses were not identified in the initial information
-Structure weights were included in the electronics
- Separation subsystem mass was included in structure
- Interstage (composite material) was included in structures (aluminum-lithium material)
-Falcon 9 test program initially included only one test flight unit

- Excludes Program Support costs (Firm Fixed Price only).
- Excludes Contingency costs (Firm Fixed Price only).
- Excludes Contractor fee (Firm Fixed Price only).

Modeling Explanation of Difference

Primary Differences In Firm Fixed Price Vs. Cost Plus Fee Acquisition		
Model Input Assumptions	**Firm Fixed Price**	**Cost Plus Fee**
1- Acquisition Strategy	No Oversight	Oversight
2- Requirements Stability	Stable	Unstable
3- Team Effeciency	Efficient	Less Efficient
4- Management Structure	Lean	Less Lean
5- Early Phase studies/Sys. Engineering	Disciplined	Less Disciplined
6- Funding Commitment	Fixed	Annual
Note: Order represents relative weighting		

Backup Material

Falcon 9 NAFCOM Cost Estimate Comparison
Initial
(Both Estimates Are Cost Plus Fee)

(All Costs Are In FY2010 $M)								
		Cost Plus Fee				Cost Plus Fee		
		Space-x Approach				NASA Approach		
Elements	Weight (lbs)	DDT&E (FY2010 $M)	Flight Unit (FY2010 $M)	Total (FY2010 $M)		DDT&E (FY2010 $M)	Flight Unit (FY2010 $M)	Total (FY2010 $M)
Stage One (Including Engines)	39,080	$614	$87	$701		$1,535	$206	$1,741
Stage Two (Including Engine)	6,520	$331	$12	$343		$608	$44	$651
Fee (12.5%)		$118	$12	$130		$268	$30	$298
Program Support (10%)		$107	$4	$111		$241	$21	$263
Contingency (30% Vehicle, 10% Engine))		$251	$11	$262		$674	$68	$741
Vehicle Level Integration (8%)		$106	$5	$111		$258	$24	$282
Total	**45,600**	**$1,528**	**$131**	**$1,659**		**$3,584**	**$393**	**$3,977**

- Based on November, 2010 weight estimate and technical data from SpaceX
- Represents DDT&E and one flight unit
- Both estimates represent cost plus fee acquisition approach (include fee, program support, and contingency)

Falcon 9 NAFCOM Updated Cost Estimate Comparison Updated

(Cost Plus Fee Vs. Firm Fixed Price)

		Firm Fixed Price Acquisition				Cost Plus Fee Acquisition		
	Weight	DDT&E	2 Test Flt Units	Total		DDT&E	2 Test Flt Units	Total
Elements	(lbs)	(FY2010 $M)	(FY2010 $M)	(FY2010 $M)		(FY2010 $M)	(FY2010 $M)	(FY2010 $M)
Stage One (Including Engines)	39,080	$188.7	$109.3	$298.0		$370.6	$218.3	$588.9
Stage Two (Including Engine)	6,506	$89.0	$23.6	$112.6		$184.7	$59.6	$244.4
Fee (12.5%)		$0.0	$0.0	$0.0		$69.4	$34.7	$104.2
Program Support (10%)		$0.0	$0.0	$0.0		$62.5	$31.3	$93.7
Contingency (30% Vehicle, 10% Engine))		$0.0	$0.0	$0.0		$193.2	$91.7	$284.9
Vehicle Level Integration (8%)		$22.2	$10.6	$32.8		$44.4	$22.2	$66.7
Total	45,586	$299.9	$143.6	$443.4		$924.9	$457.9	$1,382.7

- Based on technical corrections and the additional insight in to the mass summary information as well as hardware heritage gained from a recent trip to the SpaceX facility.
- Represents DDT&E and two test flight unit
- Cost plus fee acquisition approach include fee, program support, and contingency where firm fixed price acquisition reflects a space act agreement approach