

SEPTEMBER 18, 2008

---

AUDIT REPORT

OFFICE OF AUDITS

---

---

COST ESTIMATES USED TO SUPPORT THE  
FISCAL YEAR 2008 BUDGET REQUEST FOR  
NASA'S CONSTELLATION PROGRAM  
COULD HAVE BEEN BETTER DOCUMENTED

---

---

OFFICE OF INSPECTOR GENERAL

---

---



National Aeronautics and  
Space Administration

Final report released by:

signed

Evelyn R. Klemstine  
Assistant Inspector General for Auditing

## Acronyms

---

CCCC	Commercial Cargo Crew Capability
CEV	Crew Exploration Vehicle
CLV	Crew Launch Vehicle
CxP	Constellation Program
DDT&E	Design, Development, Test, and Evaluation
FMR	Financial Management Requirements
FTE	Full-Time Equivalent
GAO	Government Accountability Office
NPR	NASA Procedural Requirements
OCFO	Office of the Chief Financial Officer
OIG	Office of Inspector General
OMB	Office of Management and Budget
PA&E	Program Analysis and Evaluation
PPBE	Planning, Programming, Budgeting, and Execution
WBS	Work Breakdown Structures
WYE	Work-Year Equivalent

---

---

## OVERVIEW

---

# COST ESTIMATES USED TO SUPPORT THE FISCAL YEAR 2008 BUDGET REQUEST FOR NASA'S CONSTELLATION PROGRAM COULD HAVE BEEN BETTER DOCUMENTED

### The Issue

---

The NASA Office of Inspector General (OIG) conducted this audit to determine whether the fiscal year (FY) 2008 budget for the Constellation Program (CxP) was prepared in accordance with Office of Management and Budget (OMB) and NASA policy and whether the CxP budget request was supported by well-documented cost estimates. We focused our review on the five major CxP projects: the Crew Launch Vehicle, Crew Exploration Vehicle, Ground Operations, Commercial Crew Cargo Capability, and Mission Operations. The Commercial Crew Cargo Capability is considered a project under CxP in NASA's 2008 budget request and in this report; however, for program management purposes, it is its own program and is not a project under CxP. The CxP projects are intended to send a new generation of explorers to the Moon, Mars, and beyond. The project mission for the Crew Launch Vehicle (Ares I) is to deliver a safe, reliable launch system for the Crew Exploration Vehicle that will take astronauts to the International Space Station and then to the Moon by 2020. Reliable cost estimates can help ensure that budget requests are adequate to meet project and program milestones and goals.

NASA's FY 2008 budget request<sup>1</sup> totaled \$17.3 billion and included \$3.1 billion (17.7 percent) for CxP. Budget requests for the five major CxP projects totaled \$2.8 billion, which included \$2.3 billion in direct costs. Our review covered \$1.1 billion of those direct cost estimates. Details of the audit's scope and methodology are in Appendix A.

### Results

---

NASA could improve its budgeting process by providing additional guidance to ensure that budget requests are supported by well-documented cost estimates. We found that while the CxP project managers had supporting documentation for the \$1.1 billion of the direct cost estimates that we reviewed, the majority was at the summary level and not sufficiently detailed. Specifically, CxP project personnel provided summary-level

---

<sup>1</sup> [http://www1.nasa.gov/pdf/168652main\\_NASA\\_FY08\\_Budget\\_Request.pdf](http://www1.nasa.gov/pdf/168652main_NASA_FY08_Budget_Request.pdf), also available at <http://www.nasa.gov/news/budget/FY2008.html>; accessed August 12, 2008.

documentation for \$914.6 million and more detailed documentation for \$164.4 million. Although the summary-level documentation met Agency requirements for documenting budget requests and provided insight into the process used to estimate the direct costs, it did not include detailed documentation, such as the source data, calculations, and explanations, that would facilitate reproducing and independently evaluating the estimate.

For example, project personnel for one of the five projects, Commercial Cargo Crew Capability, provided limited supporting documentation for that project's FY 2008 budget request of \$193 million in direct costs. Project personnel stated that they used market research and vendor quotes to develop the cost estimates that supported the budget request and provided summary-level documentation that illustrated various cost scenarios in a PowerPoint presentation. However, the summary-level data did not include detailed evidence to show how the cost estimates were derived by market research, company responses, or vendor quotes.

A reasonable and defensible budget request should be supported and documented by sound cost estimates. OMB requires agencies to collect, identify, and analyze data for cost estimates; document cost estimates; and explain the cost estimating process used so that the estimate can be reproduced, allowing the quality of the estimate to be independently evaluated.

NASA requirements for formulating, approving, implementing, and evaluating programs and projects requires cost estimates to be consistent with guidance in NASA's "Cost Estimating Handbook," 2004. The Handbook provides useful information to assist the NASA community in the development of reliable, comprehensive, defensible, and well-documented cost estimates, stating that documentation for the estimates should provide sufficient information about how the estimate was prepared to allow an independent analyst to reproduce the estimate. However, the Handbook does not explain what constitutes sufficient information.

Given the absence of detailed guidance on what constitutes sufficient documentation, we evaluated the CxP budget request against standards recommended by the Government Accountability Office (GAO) in its July 2007 exposure draft, "Cost Assessment Guide: Best Practices for Estimating and Managing Program Costs." Although not available at the time the FY 2008 CxP budget request was submitted, and still in draft format as of August 4, 2008, the guiding principles for preparing fully documented cost estimates contained in the GAO Cost Guide are a compilation of best practices from across the Federal Government that can serve as a benchmark.

We found that the CxP project managers' documentation did not include the level of detail called for in either NASA's Handbook or the GAO Cost Guide. With respect to the Handbook, the documentation provided by the CxP project managers did not provide sufficient information to allow an independent analyst to reproduce the estimates. The GAO Cost Guide states that the documentation should include source data and

significance, clearly detailed calculations and results, and explanations of why particular methods and references were chosen. The Guide also states that the data in a well-documented cost estimate must be traceable to its source.

NASA could improve its budgeting process by adopting the standards recommended by the GAO Cost Guide and ensuring that budget requests incorporate cost estimates based on historical or actual cost data, vendor quotes, and spreadsheets with detailed calculations prepared by subject matter experts showing how they arrived at the cost estimates. Also, given that NASA programs and projects have historically experienced cost overruns, cost estimates with detailed, empirical data that explain the rationale for decisions could help minimize the risk of cost overruns by providing additional assurance that budget requests are adequate to achieve program and project goals.

## Management Action

---

We recommended that the Associate Administrator for Program Analysis and Evaluation incorporate into NASA's Cost Estimating Handbook appropriate best practices identified in the exposure draft of the GAO Cost Guide and require personnel to document and retain cost estimates used to support budget requests in a manner that explicitly identifies the primary methods, calculations, results, rationales or assumptions, and source data used to generate each estimate. We also recommended that the Constellation Program Manager require that budget requests be prepared using cost estimates that are sufficiently documented as to allow an independent cost analyst to reproduce the estimate.

In response to a draft of this report issued August 12, 2008, the Associate Administrator for Program Analysis and Evaluation nonconcurred with our first recommendation but stated that NASA incorporated the best practices from the exposure draft of the GAO Cost Guide into its 2008 Cost Estimating Handbook. By incorporating the GAO standards into the Handbook, management's actions are responsive to the recommendation.

The Associate Administrator for Program Analysis and Evaluation concurred with our second recommendation and stated that CxP has been and will continue to apply the techniques and best practices outlined in NASA's Cost Estimating Handbook. The techniques and best practices are in concert with the GAO Cost Guide. We consider management's comments to be responsive. Both recommendations will be closed upon verification of management's actions.



---

---

**CONTENTS**

---

INTRODUCTION

Background _____	1
Objectives _____	4

RESULTS

Budget Requests Could Be Improved by Using Well-Documented Cost Estimates _____	5
--	---

APPENDIX A

Scope and Methodology _____	15
Review of Internal Controls _____	17
Prior Coverage _____	17

APPENDIX B

Management Comments _____	18
---------------------------	----

APPENDIX C

Report Distribution _____	22
---------------------------	----





---

---

## INTRODUCTION

---

### Background

#### Budget Process at the Program/Project Level

Each year, the Office of Management and Budget (OMB) issues Circular No. A-11, "Preparation, Submission, and Execution of the Budget," instructing Federal agencies on how to develop and submit their annual budgets. A reasonable budget request should be supported by well-documented cost estimates. OMB requires agencies to collect, identify, and analyze data for cost estimates; document cost estimates; and explain the cost estimating process used so that the estimate can be reproduced, allowing the quality of the estimate to be independently evaluated.

NASA implemented the process for preparing, submitting, and executing its FY 2008 budget in NASA Financial Management Requirements (FMR), Volume 4, "Planning, Programming, Budgeting, and Execution" (PPBE), July 2006. The PPBE process is a methodology used Agency-wide for aligning resources in a comprehensive, disciplined, top-down approach that focuses on translating strategy into actionable programs and bringing together Agency priorities and strategic outcomes within the Agency's resource constraints. The PPBE process begins at the top with the Office of the Chief Financial Officer (OCFO) and the Office of Program Analysis and Evaluation (PA&E) preparing NASA's Strategic Planning Guidance. This Guidance is a consolidated document containing information from NASA's Strategic Plan, implementation plans, studies and assessments, and performance measures. Senior Agency officials translate the Strategic Planning Guidance into guidance more relevant for the program and project managers. The programmatic guidance details the allocation of budget control totals<sup>2</sup> to the appropriate lower levels, including programs and projects. The control totals flow down from Headquarters to the programs and projects, but each program or project may formulate its budget in any way it deems appropriate, as long as the final direct budget submission reflects the control total provided in the programmatic guidance.

NASA requirements for formulating, approving, implementing, and evaluating programs and projects are defined in NASA Procedural Requirements (NPR) 7120.5C, "NASA Program and Project Management Processes and Requirements," March 22, 2005. One responsibility the project manager has, as stated in the NPR, is to develop credible cost estimates for budget preparation. The NPR also notes that cost estimates must be consistent with guidance in NASA's "Cost Estimating Handbook," 2004. Cost estimating should tie costs with benefits and risks, creating causal links, which are

---

<sup>2</sup> The maximum amount that program and project managers should use—i.e., the control amount—when developing their budget requests.

essential for decision makers who must review and approve budgets. The Handbook states that properly estimating costs supports the budgeting process, and in order for NASA to support the objectives of OMB A-11, a reasonable estimate of resources is required. NASA's Handbook also provides useful information to assist the NASA community in the development of reliable, comprehensive, defensible, and well-documented cost estimates, stating that documentation for the estimates should provide sufficient information about how the estimate was prepared to allow an independent analyst to reproduce the estimate. However, the Handbook does not explain what constitutes sufficient information.

In July 2007, the Government Accountability Office (GAO) issued an exposure draft of "Cost Assessment Guide: Best Practices for Estimating and Managing Program Costs" (GAO-07-1134SP).<sup>3</sup> The purpose of the Cost Guide is to help Federal agencies overcome longstanding concerns about the adequacy of documentation supporting budget requests and create guidance for generating reliable cost estimates in compliance with OMB A-11. The GAO Cost Guide provides guiding principles for Government managers and auditors to use as they assess the credibility of a program's cost estimate for budget and decisionmaking purposes. Although agencies are not required to comply with the Guide, it describes generally accepted best practices for ensuring credible cost estimates and notes the importance of documenting cost estimates. Because a reasonable and supportable budget is essential to a program's efficient and timely execution, a competent estimate is the key foundation of a good budget. Credible cost estimates help program offices effectively defend budgets to Congress and OMB. Without sufficient documentation to support budget requests, Federal agencies are limited in their assurance that requests are adequate to achieve stated goals. As GAO states in the Guide: "The ability to generate reliable cost estimates is a critical function . . . Without this ability, agencies are at risk of experiencing cost overruns, missed deadlines, and performance shortfalls."

## **Constellation Program**

The Constellation Program (CxP) supports NASA's mission to pioneer the future in space exploration. As described in NASA's FY 2008 budget request,<sup>4</sup> CxP is responsible for providing the capabilities essential to this mission, to include reestablishing a U.S. presence on the Moon, which will enable significant national aspirations, such as preparing for human exploration of Mars. The FY 2008 budget request for CxP was

---

<sup>3</sup> GAO-07-1134SP was released for comment from August 13, 2007, through July 14, 2008. The methodology outlined in the Cost Guide is a compilation of best practices that Federal cost estimating organizations use to develop and maintain reliable cost estimates throughout the life of a program.

<sup>4</sup> [http://www1.nasa.gov/pdf/168652main\\_NASA\\_FY08\\_Budget\\_Request.pdf](http://www1.nasa.gov/pdf/168652main_NASA_FY08_Budget_Request.pdf), also available at <http://www.nasa.gov/news/budget/FY2008.html>; accessed August 12, 2008.

\$3.1 billion, 17.7 percent of NASA's \$17.3 billion budget, divided among the following five projects and an "Other" category:

- Crew Launch Vehicle (CLV)/Ares I. The project mission is to deliver a safe, reliable launch system that expands America's scientific reach through space exploration. The Ares I project is tasked to design, develop, test, and evaluate a human-rated CLV composed of a solid rocket booster and a new J-2X upper stage engine. Ares I will feature a lift capability of 24.5 metric tons and will launch the Orion spacecraft that will take astronauts to the International Space Station and then to the Moon by 2020.
- Crew Exploration Vehicle (CEV)/Orion. NASA's next-generation piloted spacecraft is the Orion, which will be capable of transporting six astronauts to the International Space Station or four astronauts to the Moon and returning them safely to Earth. The combined crew and service modules will provide power, life support, and propulsion for rendezvous, orbit correction, and deorbit.
- Ground Operations. This project consists of the launch site infrastructure necessary to receive, inspect, assemble, integrate, test, simulate, monitor, and perform launch processing operations and landing/recovery of flight hardware. The Ground Operations project is also engaged in defining the complete processing system at the launch site. Characteristics of a launch site system include numbers of integration cells and launch pads, launch rate capability, and associated life-cycle costs.
- Commercial Cargo Crew Capability (CCCC). This project supports demonstration of Commercial Space Transportation Services from domestic companies. NASA's Commercial Orbital Transportation Services Projects are designed to facilitate U.S. private industry demonstration of cargo and crew space transportation capabilities, with the goal of achieving reliable, cost-effective access to low Earth orbit. Although CCCC is considered a project under CxP in NASA's 2008 budget request and in this report, for program management purposes, it is its own program and is not a project under CxP.
- Mission Operations. This project will provide all mission operation capabilities needed to execute Constellation missions, including the systems and infrastructure necessary for Constellation command and control during ascent, descent, and mission operation execution. Mission Operations also supports the interoperability of control center facilities with other control centers and test sites.
- Other. This category includes six smaller projects: Ares V, Program Integration, Exploration Communication and Navigation System, Advanced Development, Extra Vehicular Activity, and Advanced Projects.

The FY 2008 budget requests for CxP projects (see Table 1) include direct costs, indirect costs,<sup>5</sup> and pass-back adjustments.<sup>6</sup> For the five major projects, we reviewed the direct cost portion of the budget requests (see Table 2, page 8). The direct costs are estimated by NASA personnel, while indirect costs are determined by a formula and pass-back adjustments are outside of an agency's control. Therefore, we did not review those costs. We also did not review the "Other" costs of \$301.9 million. Therefore, only direct costs of the five major projects are discussed in this report. Also, because our review was not based on statistical sampling, our results cannot be projected.

<b>Table 1. FY 2008 Budget Requests by CxP Project</b> (dollars in millions)	
<u>Project</u>	<u>Budget Request</u>
CLV/Ares I	\$1,175.2
CEV/Orion	950.8
Ground Operations	356.8
CCCC	236.0
Mission Operations	47.4
Other	301.9
<b>Total</b>	<b>\$3,068.0*</b>
*The total does not add up because of rounding.	

## Objectives

The overall audit objective was to determine whether the Constellation Program's FY 2008 budget request was prepared in accordance with OMB A-11 and NASA FMR, Volume 4, and was supported by well-documented cost estimates. During the course of our audit, we reviewed NPR 7120.5C, NASA's Cost Estimating Handbook, and the GAO Cost Guide because these criteria contained requirements and guidance for supporting budget requests with documented cost estimates. We also reviewed internal controls as they related to our overall audit objective. See Appendix A for details of the audit's scope and methodology, our review of internal controls, and a list of prior coverage.

<sup>5</sup> Overhead, general and administrative (G&A) costs, and shared services costs.

<sup>6</sup> OMB's notification to agencies of budget, management, and policy decisions following its analysis and review of all agency budget submissions.

---

---

## BUDGET REQUESTS COULD BE IMPROVED BY USING WELL-DOCUMENTED COST ESTIMATES

---

NASA could improve its budgeting process by providing additional guidance to ensure that budget requests are supported by well-documented cost estimates. We found that while the CxP project managers had supporting documentation for the \$1.1 billion of direct cost estimates that we reviewed, the majority (\$914.6 million) was at the summary level and not sufficiently detailed. Although the summary-level documentation, such as PowerPoint slides featuring cost overviews, met Agency requirements for documenting budget requests and provided insight into the process used to estimate the direct costs, it did not include detailed documentation, such as the source data, calculations, and explanations. As stated in NASA's Handbook, the documentation should provide sufficient information to facilitate reproducing and independently evaluating the cost estimate.

We found that the five project managers maintained minimal documentation for the cost estimates used to support their budget requests because the type of documents or the depth of related analysis needed is not specified in OMB and NASA requirements. Given the absence of specific guidance, we evaluated the CxP budget request against standards of the GAO Cost Guide. We found that the CxP project managers' documentation did not include the level of detail called for by GAO.

Although the GAO Cost Guide was not available at the time the FY 2008 CxP budget request was submitted, NASA could improve its budgeting process by adopting the Guide's recommended standards and ensuring that budget requests incorporate well-documented cost estimates, which could help minimize the risk of cost overruns by providing additional assurance that budget requests are adequate to achieve program and project goals.

### Federal and NASA Requirements and Guidance

Numerous requirements, policies, and guidance govern the annual budget process at NASA. OMB issues requirements for all Federal agencies to follow in the preparation of their annual budget submission to the President. NASA provides guidance for preparing annual budgets in its FMR, NPRs, and Cost Estimating Handbook. The GAO Cost Guide details best practices for Federal agencies to follow in documenting and preparing credible cost estimates to support budget requests and decisionmaking.

**OMB Requirement.** The June 2006 edition of OMB A-11 provides requirements for preparing the FY 2008 budget submission. OMB A-11 instructs Federal agencies on how

to develop and submit their annual budgets and requires agencies to collect, identify, and analyze data for cost estimates; document cost estimates; and explain the cost estimating process, allowing the quality of the estimate to be independently evaluated. Appendix 9 of the “Capital Programming Guide,” a supplement to OMB A-11, states that program personnel should document cost estimates and that the documentation should explain the cost estimating process used and how the cost estimates were prepared so that the quality of the estimate can be determined. OMB requires thoroughly documented data, including any adjustments made, so that an audit trail is established for verification purposes.

**NASA Requirements and Guidance.** NASA’s requirements and guidance are provided in NASA FMR, Volume 4; NPR 7120.5C; and NASA’s Cost Estimating Handbook.

Volume 4 of the NASA FMR details the PPBE process, which was established to assist NASA program and project staff to implement the requirements in OMB A-11 for preparing, submitting, and executing budgets. The PPBE process uses a methodology for aligning resources in a comprehensive, disciplined, top-down approach that focuses on translating strategy into actionable programs and bringing together Agency priorities and strategic outcomes.

NPR 7120.5C defines the management requirements for formulating, approving, implementing, and evaluating NASA programs and projects. Section 3.2.2.1 states that the project manager and the team should develop credible cost estimates for budget preparation. Further, this section states that good cost estimation is a critical capability needed to ensure the credibility of the project’s resource and financial decisionmaking and, in the larger view, the credibility of NASA’s financial management system. The NPR also states that cost estimating should be consistent with the Cost Estimating Handbook.

Although NASA’s Cost Estimating Handbook does not provide actual policy guidance or project requirements, it provides useful information on developing credible cost estimates. The Handbook states that properly estimating costs supports the budgeting process, and in order for NASA to support the objectives of OMB A-11, a reasonable estimate of resources is required. Task 10 in Chapter 5, Section 5.3, “Estimate,” provides information on how to document cost estimates. The Handbook states that the objective of documenting cost estimates is to capture, in a continuous fashion, from project initiation through completion, the life-cycle cost. Specifically, the purpose of the documentation is to provide written justification for the cost estimate. The final cost estimate should provide sufficient detail about how the estimate was developed so that independent analysts—or other review team members—can reproduce the estimate. The Handbook also states that the means by which each part of an estimate has been derived must be fully explained.

**GAO Guidance.** The GAO Cost Guide states that certain best practices should be followed if accurate and credible cost estimates are to be developed. It states that a reasonable and supportable budget is essential to a program’s efficient and timely

execution and that a competent estimate is the key foundation of a good budget. The Cost Guide states that an estimate is thoroughly documented if it includes source data and significance, clearly detailed calculations and results, and explanations of why particular methods and references were chosen. The Guide also states that the data in a well-documented cost estimate must be traceable to its source. Well-documented cost estimates are considered high-quality cost estimates for several reasons. First, thorough documentation is essential for validating and defending a cost estimate. Second, documenting the estimate in detail provides enough information so that someone unfamiliar with the program could easily recreate or update it. Third, good documentation helps with analyzing changes in program costs and contributes toward the collection of cost data that can be used to support future estimates. Finally, a well-documented cost estimate is essential if an effective independent review is to ensure that the estimate is valid and credible. The documentation should explicitly identify the primary methods, calculations, results, rationales or assumptions, and source data used to generate each cost estimate. The Guide states that data sources should also be documented. Examples of data sources include basic accounting records, historical databases, subject matter experts, contractor estimates, cost proposals, and research papers.

### **Improving Supporting Documentation**

For the five project budgets we reviewed, the project personnel provided summary-level data regarding the assumptions, risks, estimating rationales, and cost estimating processes used for the budget requests. They did not provide source data, such as spreadsheets, vendor quotes, or subject matter expert calculations, to further support the cost estimates. Project personnel provided summary-level data for \$914.6 million of the \$1.1 billion reviewed. Project personnel stated that the documentary evidence they prepared satisfied Agency requirements for documenting budget requests. NASA's guidance states that the documentation for the estimates should contain sufficient information for an independent analyst to reproduce the estimate but does not specify the types of information required nor the level of detail. Because of the discretion allowed by OMB A-11 and the NASA guidance, we evaluated the CxP budget request against standards of the GAO Cost Guide. By following the Guide's best practices, NASA could improve its budgeting process by documenting its cost estimates with more detailed support. The detailed support should include the methods, calculations, and source data used to develop the cost estimates. By grounding cost estimates with detailed, empirical data that explains the rationale for estimation decisions, NASA can enhance its assurance that budget requests are adequate to finance the CxP and minimize the risk of project overruns.

The projects that we reviewed used work breakdown structures (WBS)—a management device to define and assign program tasks—to define and organize the scope of the project. Therefore, we based our audit work on the WBS. We used two key criteria to select WBS for review: WBS with high dollar value and WBS that included a mix of labor, travel, and procurement costs. The amounts that we examined accounted for

approximately 50 percent of the \$2.3 billion of direct costs estimated for the five CxP projects. However, because our selection was not based on statistical sampling, our results cannot be projected.

Table 2 summarizes the results of our review. The direct costs estimates are from the projects' budget submissions to CxP. The project managers had supporting documentation for all of the amounts that we reviewed, some at the summary level and some sufficiently detailed, as shown in Table 2.

<b>Table 2. Analysis of Five CxP Projects' FY 2008 Budget Requests</b> (dollars in millions)				
<u>Project</u>	<u>Estimate of Direct Costs Submitted to CxP</u>	<u>Amount of Estimate Reviewed</u>	<u>Summary Support</u>	<u>Sufficient Support</u>
CLV/Ares I	\$1,009.0	\$ 539.9	\$539.6	\$ 0.3
CEV/Orion	815.3	211.3	102.9	108.4
Ground Operations	290.4	113.9	61.3	52.6
CCCC	193.0	193.0	193.0	0
Mission Operations	33.6	20.9	17.8	3.1
<b>Total</b>	<b>\$2,341.3</b>	<b>\$1,079.0</b>	<b>\$914.6</b>	<b>\$164.4</b>

**Crew Launch Vehicle (CLV/Ares I).** The CLV project's FY 2008 budget submissions to CxP totaled \$1 billion. Project personnel provided a breakout of the submission by WBS, Center, and cost element. We chose two WBS totaling \$539.9 million to review and determine whether sufficient support existed for the cost estimates.

Project personnel provided summary-level support for most of the \$539.9 million. That support included a breakout of full-time equivalent (FTE) staff, work-year equivalents (WYEs),<sup>7</sup> and procurement and travel costs as well as information about their estimation rationale and assumptions. For \$0.3 million, project personnel provided detailed source data (vendor quotes), but could not provide source data for the remaining \$539.6 million. Although they stated that they based the cost estimates on historical data, they could not provide documentation of the actual historical data to verify their rationale.

Cost estimates prepared to support budget requests using GAO best practices would have included detailed information on the specific historical costs discussed and the rationale for the calculations used to adjust the historical data to arrive at the estimates.

<sup>7</sup> Contract staff working a full work year.



**Crew Exploration Vehicle (CEV)/Orion.** The CEV project's FY 2008 budget submissions to CxP totaled \$815.3 million, consisting of prime (contractor) and non-prime (in-house) cost estimates. We chose five WBS valued at \$211.3 million to determine whether there was adequate support for the cost estimates. The prime, or contractor, cost estimates consisted of design, development, test, and evaluation (DDT&E) costs. The non-prime cost estimates consisted of DDT&E and costs for NASA management oversight.

Project personnel provided sufficient support for \$108.4 million of prime costs. The CEV is a new project in the early stages of developing cost estimates, and at the time the project formulated its budget request, it had not yet awarded any contracts for its prime costs. Therefore, to generate prime cost estimates, project personnel used the NASA Air Force Cost Model, a software application used by the U.S. Air Force when estimating the cost of new projects, a product NASA had previously used to estimate the costs for new projects. For CEV, the model was used to calculate costs based on data from past programs, such as Apollo and Gemini. CEV project personnel provided a demonstration of the model and the various components used to calculate the costs. For example, project personnel demonstrated how the model uses Shuttle subassemblies to estimate similar components for CEV. They provided screen shots (printouts of the computer screen) from the model and explained how they applied factors such as complexity, weight, class, and inflation to the estimates.

Project personnel did not provide similarly detailed support for \$102.9 million of non-prime costs. Project personnel provided summary-level support; which included PowerPoint presentations showing content descriptions, estimating rationale, and assumptions; however, they did not provide detailed information showing the calculations used to arrive at the cost estimates. Although the summary-level data provided background information on the estimating process, the source data behind the estimates lacked detailed evidence. The CEV project office based the majority of the non-prime cost estimates on the professional opinion of subject matter experts but did not document the rationale for their decisions. For instance, we requested the source data to support the estimated number of FTEs for one particular WBS. Project personnel stated that subject matter experts derived the estimates based on prior experience from other projects. However, the subject matter experts did not document how the experience related to this project or how they used the prior history to calculate the estimates.

Cost estimates prepared to support budget requests using GAO best practices would have included documentation such as spreadsheets and calculations from the subject matter experts that linked their previous experience with the current cost estimates.

**Ground Operations.** The FY 2008 budget submissions to CxP for Ground Operations totaled \$290.4 million. We requested support for \$113.9 million, which included \$52.6 million of material costs for the Mobile Launch Platform and \$36.7 million of material costs for the Vehicle Assembly Building High Bay 3 area. We also requested support for \$24.6 million of labor costs consisting of 66 FTEs and 105 WYE positions.

The project personnel provided sufficient support for the Mobile Launch Platform material budget of \$52.6 million. The support consisted of schedules, assumptions, and spreadsheets capturing the calculations used to derive the estimated costs.

Project personnel provided summary-level support for the remaining \$61.3 million of the cost estimates (\$36.7 million for Vehicle Assembly Building material costs and \$24.6 million for labor costs). For the \$36.7 million, project personnel provided a summary-level breakdown for selected budget items and stated that they had more detailed documentation; however, they were unable to provide further detailed documentation or source data beyond the summary-level breakdown. For the \$24.6 million, project personnel provided some support for \$15.7 million; however, the support they provided was limited. We could not trace the labor costs detailed in the spreadsheets back to the budget submission. Project personnel explained that the differences resulted from reducing the number of FTEs in the initial estimates; however, no rationale or calculations were provided as documentation for the reduction. Project personnel also did not provide any supporting documentation for the remaining \$8.9 million of labor costs. Consequently, we considered the support for the \$24.6 million of labor costs of limited benefit.

Cost estimates prepared to support budget requests using GAO best practices would have included source documentation such as historical cost data or vendor quotes for the material costs and spreadsheets detailing the rationale and calculations for the reductions in labor costs.

**Commercial Cargo Crew Capability (CCCC).** The CCCC project's FY 2008 budget submissions to CxP totaled \$193 million. We reviewed the entire amount because the project personnel did not have the budget broken out by WBS. Project personnel verbally explained that the cost estimates included procurement, travel, and labor costs.

Project personnel provided limited supporting documentation for the \$193 million. Specifically, project personnel explained that they derived the cost estimates by performing market research and soliciting vendor quotes from various companies by using Requests for Information. Project personnel provided summary-level documentation that illustrated various cost scenarios in a PowerPoint presentation. The summary-level data did not include detailed evidence to show how the estimates were derived by market research, company responses, or vendor quotes.

Cost estimates prepared to support budget requests using GAO best practices would have included source documentation to show all parameters, assumptions, descriptions, methods, and calculations used to develop a cost estimate, such as company responses and vendor quotes.

**Mission Operations.** The FY 2008 budget submissions to CxP for Mission Operations totaled \$33.6 million. We chose three WBS from the budget submission valued at \$20.9 million to determine whether sufficient support existed for the cost estimates.

Project personnel provided sufficient supporting documentation for \$3.1 million. The documentation included a description of the task/function requirements, the estimating rationale used, and the possible impact of a funding reduction. Project personnel also provided spreadsheets detailing the calculations of the estimates.

Project personnel provided some support for the remaining \$17.8 million. They verbally explained the rationale for the costs; however, they did not document the calculations used to arrive at the cost estimates. For example, we reviewed the estimates for a training simulator system engineering team that would aid in developing the architecture, requirements, and acquisition planning for the Mission Control Center. Project personnel could not provide details or calculations to show how they derived the number of staff estimated for the team. Subject matter experts derived the estimates based on their professional opinion; however, they did not document the rationale or calculations used.

Cost estimates prepared to support budget requests using GAO best practices would have included source documentation such as spreadsheets and subject matter expert calculations showing how they derived the estimates.

### **Benefit of Improved Budget Support**

Cost estimating is an integral part of the Federal budget preparation process, and support for the cost estimates needs to be sufficiently detailed to ensure the reliability of the estimates. In Senate Report 110-397, “Departments of Commerce and Justice, Science, and Related Agencies Appropriations Bill, 2009,” the Senate Appropriations Committee expressed its concern about NASA’s documentation, stating:

The Committee continues to be disappointed in the lack of detail provided in NASA’s fiscal year 2009 congressional budget justification document. Budget justifications are critical to the Committee’s ability to make informed decisions concerning the administration’s funding requests and must be submitted in a format with the greatest level of detail possible. NASA has made an incremental change in providing additional details in their budget justification, but the agency has not complied fully with the direction in Public Law 110-161 which specifically asked for funding levels by directorate, theme, program, project, and activity. NASA has yet to disclose such data in its budget material provided to the Committee as prescribed in the law, and the Committee insists that NASA comply with the law in future budget submissions.

Supporting budget requests with cost estimates based on actual and historical evidence could help minimize the risk of cost overruns by providing additional assurance that budget requests are adequate to achieve program and project goals. Similarly, historical cost data provide a baseline for estimating future costs and budget modifications. Without sufficient documentation of source data used for cost estimates, managers cannot determine whether budget requests are reasonable to support the program or project nor can they be assured that they are safeguarding the public’s interests and avoiding project overspending. NASA programs and projects have historically experienced cost overruns. NASA’s FY 2009 budget request reported cost overruns, as required by the NASA

Authorization Act of 2005, showing that 4 out of 12 new NASA programs are over budget by 15 percent or more. Improved cost estimates could reduce NASA's risk of cost overruns, missed deadlines, and performance shortfalls.

NPR 7120.5C requires cost estimates to be consistent with guidance in NASA's Handbook, and the Handbook provides useful information to assist the NASA community in the development of reliable, comprehensive, defensible, and well-documented cost estimates. The Handbook states that documentation for the estimates should provide sufficient information about how the estimate was prepared to allow an independent analyst to reproduce the estimate, but the Handbook does not explain what constitutes sufficient information.

### **Recommendations, Management's Response, and Evaluation of Management's Response**

**Recommendation 1.** The Associate Administrator for Program Analysis and Evaluation should incorporate into NASA's Cost Estimating Handbook appropriate best practices identified in the exposure draft of the GAO Cost Guide and require personnel to document and retain cost estimates used to support budget requests in a manner that explicitly identifies the primary methods, calculations, results, rationales or assumptions, and source data used to generate each estimate.

**Management's Response.** The Associate Administrator for Program Analysis and Evaluation nonconcurred with our recommendation. However, NASA has included the proposed exposure draft GAO Cost Guide standards into the Agency's 2008 Cost Estimating Handbook. The Associate Administrator stated that the proposed standards in the GAO Cost Guide apply to improvement of point-in-time estimates but are not directly pertinent to the documentation of annual budget development. While properly documented cost estimates are a key component of the process of budget formulation, cost estimates are only one of a number of inputs that are evaluated in forming a program budget. The budgeting process cannot be considered as a point-in-time exercise in optimization; rather, it is updated every year, comparing the most recent cost estimates with available resources and determining the best plan given the most recent information. This underscores the limitations of cost estimates assessed at a single point in time; early in development, estimates are based on immature program requirements and uncertain budget availability. The relevant guidance to assess CxP's FY 2008 budget was embodied in OMB A-11, the FY 2008 Strategic Planning Guidance, and the Programmatic Resource Guidance. The Associate Administrator further stated that NASA project and program cost estimates are routinely independently evaluated by Standing Review Boards and reconciled by senior management as part of the process required by NPR 7120.5D, "NASA Space Flight Program and Project Requirements," March 5, 2007.

**Evaluation of Management’s Response.** The Associate Administrator’s comments are responsive because the GAO standards have been incorporated into the 2008 Cost Estimating Handbook. However, we take exception with NASA’s characterization of the GAO Cost Guide as “not directly pertinent to the documentation of annual budget development.” We believe the standards set forth in the GAO Cost Guide provide guidance on documenting cost estimates and, if followed, would enhance the credibility of NASA’s cost estimates used to support budget requests. We acknowledge that cost estimation is a process that serves multiple purposes. The exposure draft of the GAO Cost Guide states that one of the main purposes of cost estimates is to support the budget process by providing estimates of funding required to efficiently execute a program. Cost estimates are necessary for Government programs for many reasons: supporting decisions about whether to fund one program over another, developing annual budget requests, and evaluating resource requirements at key decision points. Moreover, having a realistic estimate of projected costs makes for effective resource allocation, and it increases the probability of a program’s success. The recommendation is resolved and will be closed upon verification of management’s actions.

**Recommendation 2.** The Constellation Program Manager should require that budget requests be prepared using cost estimates that are sufficiently documented as to allow an independent cost analyst to reproduce the estimate.

**Management’s Response.** The Associate Administrator of Program Analysis and Evaluation concurred, stating that CxP continues to be committed to producing high quality cost estimates for managing its program and projects. NASA has developed several initiatives to improve cost estimating and management within the Agency, one example is the NASA Cost Estimating Handbook. The Handbook describes cost estimating as it should be applied to NASA projects and provides information on cost estimating and analysis practices. CxP has been and will continue to apply the techniques and best practices outlined in the NASA Cost Estimating Handbook. The techniques and best practices are in concert with the GAO Cost Guide.

**Evaluation of Management’s Response.** Management’s comments are responsive. The recommendation is resolved and will be closed upon verification of management’s actions.



---



---

**APPENDIX A**


---

## Scope and Methodology

We performed this audit from August 2007 through July 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We performed fieldwork at Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center, and NASA Headquarters. We selected five major CxP projects to review: Crew Launch Vehicle, Crew Exploration Vehicle, Ground Operations, Commercial Crew Cargo Capability, and Mission Operations. We reviewed the information in the “National Aeronautics and Space Administration President’s FY 2008 Budget Request” and in the CxP projects’ submissions for that document. The five projects’ FY 2008 budget requests for direct costs totaled over \$2.3 billion. For each of the five projects, we requested copies of the budget submissions that project personnel provided to the Constellation Program Office. The project offices provided us the direct costs broken out by WBS. We reviewed the entire budget for CCCC and, for the other four projects, we selected between two and five WBS with the highest dollar value to maximize the amount of the overall budget included for review (see Table 3). We also selected WBS that had a mix of labor, travel, and procurement costs.

<b>Table 3. WBS and Amounts Reviewed</b> (dollars in millions)		
<u>Project</u>	<u>Number of WBS Reviewed</u>	<u>Amount Reviewed</u>
CLV/Ares I	2	\$ 539.9
CEV/Orion	5	211.3
Ground Operations	3 <sup>a</sup>	113.9
CCCC	— <sup>b</sup>	193.0
Mission Operations	3	20.9
<b>Total</b>	<b>13</b>	<b>\$1,079.0</b>
<sup>a</sup> Portions of 3 WBS were reviewed (totaling \$113.9). <sup>b</sup> The CCCC budget was not broken out by WBS.		

We requested detailed support for the cost estimates and reviewed the documentation provided by CxP project personnel. For all of the amounts that we reviewed, CxP project personnel provided overall summary documentation, such as PowerPoint presentations that contained labor, procurement, and travel costs. Because that documentation did not provide the level of detail needed to adequately support the estimates, we requested additional documentation. CxP project personnel provided additional documentation that was sufficiently detailed for \$164.4 million of the \$1,079 million that we reviewed.

We interviewed key project, program, and Exploration Systems Mission Directorate personnel as well as PA&E and OCFO staff to determine their roles and responsibilities in the budget formulation process and whether they were issued budget formulation guidance.

Specifically, we requested data to determine whether

- PA&E and OCFO issued and disseminated guidance to appropriate Mission Directorates,
- the Exploration Systems Mission Directorate issued and disseminated guidance to the Constellation Program Office, and
- the Constellation Program Office issued and disseminated guidance to its project offices.

We reviewed the following documents relating to budget formulation:

- OMB Circular No. A-11, “Preparation, Submission, and Execution of the Budget,” June 2006
- OMB Capital Programming Guide, Version 2.0, “Supplement to OMB Circular A-11, Part 7: Planning, Budgeting, and Acquisition of Capital Assets,” June 2006
- Exposure Draft, “Cost Assessment Guide: Best Practices for Estimating and Managing Program Costs” (GAO-07-1134SP, July 2007)
- “GAO Standards for Internal Control in the Federal Government” (GAO/AIMD-00-21.3.1, November 1999)
- NASA FMR, Volume 4, “Planning, Programming, Budgeting, and Execution,” July 2006
- NPR 7120.5C, “NASA Program and Project Management Processes and Requirements,” March 22, 2005
- NASA’s “Cost Estimating Handbook,” 2004

**Use of Computer-Processed Data.** We did not use computer-processed data to perform this audit.



## Review of Internal Controls

We evaluated whether CxP had internal controls in place to ensure its budget request was adequately supported. We asked the project managers of the five major CxP projects that we reviewed what internal control mechanisms were in place at the project level in FY 2006 during the FY 2008 PPBE budget formulation process to ensure that cost estimates used to support the budget request were adequately documented. We also asked CxP project managers to identify the internal controls in place and provide evidence that they were in place and functioning effectively. In addition, we searched NASA budget-related guidance to determine whether the guidance identified a system of internal controls for preparing and reviewing budgets at the project and program levels and whether the system was sufficient to ensure that cost estimates were supported by adequate documentation. As discussed in this report, the budget process could be improved. Our recommendations, if implemented, will improve the controls over the budget formulation process.

## Prior Coverage

During the last 5 years, GAO and the NASA OIG have issued five reports of particular relevance to the subject of this report. Unrestricted reports can be accessed over the Internet at <http://www.gao.gov> (GAO) and <http://oig.nasa.gov/audits/reports/FY08/> (NASA).

### Government Accountability Office

“NASA: Agency Has Taken Steps Toward Making Sound Investment Decisions for Ares I But Still Faces Challenging Knowledge Gaps” (GAO-08-51, October 2007)

“NASA: Long-Term Commitment to and Investment in Space Exploration Program Requires More Knowledge” (GAO-06-817R, July 17, 2006)

“Space Shuttle: Costs for Hubble Servicing Mission and Implementation of Safety Recommendations Not Yet Definitive” (GAO-05-34, November 2004)

“NASA: Lack of Disciplined Cost Estimating Processes Hinders Effective Program Management” (GAO-04-642, May 2004)

### National Aeronautics and Space Administration

“Failures in Cost Estimating and Risk Management Weaknesses in Prior Space Launch Initiative” (IG-03-023, September 29, 2003)

---



---

## MANAGEMENT COMMENTS

---

National Aeronautics and  
Space Administration  
**Headquarters**  
Washington, DC 20546-0001



September 12, 2008

Reply to Attn of: Office of Program Analysis and Evaluation

TO: Assistant Inspector General for Auditing  
FROM: Associate Administrator for Program Analysis and Evaluation  
SUBJECT: NASA's Response to the Office of Inspector General's Draft Audit Report, "Cost Estimates Used to Support the Fiscal Year 2008 Budget Request for NASA's Constellation Program Could Have Been Better Documented" (A-07-017-00)

In response to each of the recommendations contained in the Draft Audit Report "Cost Estimates Used to Support the Fiscal Year 2008 Budget Request for NASA's Constellation Program Could Have Been Better Documented", we have developed the following responses:

**IG Recommendation:** The Associate Administrator for Program Analysis and Evaluation should incorporate into NASA's Cost Estimating Handbook appropriate best practices identified in the GAO Cost Guide and require personnel to document and retain cost estimates used to support budget requests in a manner that explicitly identifies the primary methods, calculations, results, rationales or assumptions, and source data used to generate each estimate.

**Response:** NASA does not concur with this recommendation, although it has included the proposed exposure draft Government Accountability Office (GAO) cost guide standards in the Agency's 2008 Cost Estimating Handbook. The proposed standards certainly apply to improvement of point-in-time cost estimates, but are not directly pertinent to the documentation of annual budget development.

The draft report reviews (pg i) whether the FY08 Budget was prepared in accordance with Office of Management and Budget and NASA budget development policy. While properly documented cost estimates are indeed a key *component* of the process of budget formulation, cost estimates are only one of a number of inputs that are evaluated in forming a program budget. There is a significant distinction between estimating the eventual cost of a mission and the process by which a budget is created. The relevant guidance to assess whether the Constellation Program FY 2008 budget was prepared in accordance with OMB and NASA policy was embodied in OMB A-11, the FY 2008 Strategic Planning Guidance (SPG) and the Programmatic Resource Guidance (PRG).

These are the criteria against which to consider the adequacy of the material supporting the budget formulation, (Program, Planning, Budget and Execution (PPBE), process), not the Cost Estimating Handbook.

A cost estimate is a key piece of information in the budget development process, but it is not the only piece of information. The NASA budget is created through an iterative process where scarce resources are aligned to organizational goals in the most effective way possible. The budgeting process can not be considered as a point-in-time exercise in optimization; rather it is updated every year, comparing the most recent cost estimates with available resources and determining the best plan given the most recent information. This underscores the limitations of cost estimates assessed at a single point in time; early in development, estimates are often based on immature program requirements and uncertain budget availability. For projects later in development, for example after the Key Decision Point C Preliminary Design Review and project confirmation, estimates are more mature. If available budgets do not meet the optimum program need, re-phasing occurs for the implementation year through Operating Plan updates, or for future years, through an updated President's Budget Request.

We do note that NASA has incorporated the GAO July 2007 exposure draft standards into its 2008 Cost Estimating Handbook update. Further, NASA project and program cost estimates *are routinely independently evaluated* by Standing Review Boards (SRBs), and reconciled by senior management, as part of the process required by NASA Procedural Requirement (NPR) 7120.5D, NASA Space Flight Program and Project Requirements. These reconciled estimates are presented at each Key Decision Point to the Agency Program Management Council. Such *independent* cost estimation would not be possible if the supporting data the IG recommends requiring were not already available. SRB evaluations are documented as part of the Agency's governance system.

We request that the GAO July 2007 exposure draft be consistently referenced as an exposure draft in the final report (including the text of the formal recommendation).

**IG Recommendation:** The Constellation Program Manager require that budget requests be prepared using cost estimates that are sufficiently documented as to allow an independent cost analyst to reproduce the estimate.

**Response:** NASA concurs with the IG recommendation that budget requests be prepared using cost estimates that are sufficiently documented. The Constellation Program continues to be committed to producing high quality cost estimates for managing its program and projects in an effort to maintain the Agency's credibility and sustain external stakeholder support for the program. NASA has developed several initiatives to improve cost estimating and management within the Agency; one example is the NASA Cost Estimating Handbook. The handbook describes cost estimating as it should be applied to NASA projects and provides information on cost estimating and analysis practices. It does not provide actual policy guidance or project requirements, however it does provide details on how one would implement cost estimating requirements found in NPR 7120.5D. The Constellation program has been and will continue to apply the

techniques and best practices outlined in the NASA Cost Estimating Handbook. As noted above, the techniques and best practices are in concert with the GAO Cost Assessment Guide.

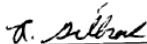
If you have any questions about this response, please contact Dennis Boccippio at [Dennis.Boccippio@nasa.gov](mailto:Dennis.Boccippio@nasa.gov) or 202-358-4749.



W. Michael Hawes

cc:  
OCFO/Mr. Spoehel

Concurred by:

  
\_\_\_\_\_  
Richard Gilbrech  
Associate Administrator  
for Exploration Systems Mission Directorate

---

---

## REPORT DISTRIBUTION

---

### **National Aeronautics and Space Administration**

Administrator  
Deputy Administrator  
Chief of Staff  
Associate Administrator for Exploration Systems  
    Constellation Program Manager  
Associate Administrator for Program Analysis and Evaluation  
Chief Financial Officer

### **Non-NASA Organizations and Individuals**

Office of Management and Budget  
    Deputy Associate Director, Energy and Science Division  
        Branch Chief, Science and Space Programs Branch  
Government Accountability Office  
    Director, Defense, State, and NASA Financial Management, Office of Financial  
        Management and Assurance  
    Director, NASA Issues, Office of Acquisition and Sourcing Management

### **Congressional Committees and Subcommittees, Chairman and Ranking Member**

Senate Committee on Appropriations  
    Subcommittee on Commerce, Justice, Science, and Related Agencies  
Senate Committee on Commerce, Science, and Transportation  
    Subcommittee on Space, Aeronautics, and Related Sciences  
Senate Committee on Homeland Security and Governmental Affairs  
House Committee on Appropriations  
    Subcommittee on Commerce, Justice, Science, and Related Agencies  
House Committee on Oversight and Government Reform  
    Subcommittee on Government Management, Organization, and Procurement  
House Committee on Science and Technology  
    Subcommittee on Investigations and Oversight  
    Subcommittee on Space and Aeronautics

Major Contributors to the Report:

Daniel Devlin, Director, Financial and Institutional Management Directorate

Mark Benson, Auditor

Daniel Birnbaum, Auditor

Mike Bruns, Auditor

Tekla Szelong, Auditor

Bobbie Wells, Auditor

Elizabeth Shifflett, Report Process Manager



OFFICE OF AUDITS

OFFICE OF INSPECTOR GENERAL

ADDITIONAL COPIES

Visit <http://oig.nasa.gov/audits/reports/FY08> to obtain additional copies of this report, or contact the Assistant Inspector General for Auditing at 202-358-1232.

COMMENTS ON THIS REPORT

In order to help us improve the quality of our products, if you wish to comment on the quality or usefulness of this report, please send your comments to Ms. Jacqueline White, Director of Special Projects and Quality Assurance, at [Jacqueline.White@nasa.gov](mailto:Jacqueline.White@nasa.gov) or call 202-358-0203.

SUGGESTIONS FOR FUTURE AUDITS

To suggest ideas for or to request future audits, contact the Assistant Inspector General for Auditing. Ideas and requests can also be mailed to:

Assistant Inspector General for Auditing  
NASA Headquarters  
Washington, DC 20546-0001

NASA HOTLINE

To report fraud, waste, abuse, or mismanagement, contact the NASA OIG Hotline at 800-424-9183 or 800-535-8134 (TDD). You may also write to the NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, Washington, DC 20026, or use <http://oig.nasa.gov/hotline.html#form>. The identity of each writer and caller can be kept confidential, upon request, to the extent permitted by law.