

National Aeronautics and  
Space Administration



**Office of Inspector General**  
Washington, DC 20546-0001

March 27, 2009

**TO:** Associate Administrator, Science Mission Directorate  
Assistant Administrator, Office of Infrastructure  
Director, Ames Research Center  
Director, Dryden Flight Research Center

**FROM:** Assistant Inspector General for Auditing

**SUBJECT:** Final Memorandum on Audit of the Stratospheric Observatory for Infrared Astronomy (SOFIA) Program Management Effectiveness (Report No. IG-09-013; Assignment No. A-08-011-00)

NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA), an airborne observatory within the airframe of a Boeing 747SP, will study the universe in the infrared spectrum. NASA began SOFIA Program formulation in 1991, initiated development in 1996, and the Program has since experienced cost overruns and schedule delays. Costs have exceeded 217 percent of the initial cost estimate and limited scientific operations are approximately 10 years behind the original schedule. As of January 2009, the SOFIA Program's life-cycle cost estimates were approximately \$1.1 billion for development and implementation and approximately \$3.4 billion including a 20-year operational lifespan. We initiated this audit in light of the Program's historical management issues and aircraft maintenance concerns.

The overall objective of this audit was to determine whether NASA was effectively managing the SOFIA Program to accomplish the near- and long-term objectives while meeting established milestones and controlling costs. Specifically, we determined whether SOFIA Program management had effectively planned for the long-term servicing of the aircraft, implemented effective controls to limit further cost growth and schedule delays, and monitored contractor performance. We also reviewed internal controls as they related to the objectives. See Enclosure 1 for details on the audit's scope and methodology.

### ***Executive Summary***

SOFIA Program management had made significant progress in identifying and addressing past problems associated with management structure, schedule, and quality assurance. Program management had established adequate risk assessment and quality assurance processes to oversee contractor performance with respect to the accomplishment of near-term goals. However, we found that Program management had not yet completed actions required to address the long-term servicing needs of the aircraft, had not requested an independent cost estimate (ICE), and lacked an effective

cost control process to evaluate the Program's cost efficiency in meeting schedule milestones. As a result, Program management cannot accurately assess the effects of long-term aircraft servicing and maintenance on the Program's life-cycle costs, demonstrate cost efficiencies, or provide earned value for completed contractor work.

SOFIA Program management had initiated some actions to address the long-term objectives related to maintaining and providing spare parts for the 30-year-old SOFIA aircraft. Program management drafted logistics and maintenance plans, and the Director, Dryden Flight Research Center, submitted a request to the Assistant Administrator for Infrastructure to obtain the two Shuttle Carrier Aircraft following the retirement of the Space Shuttle Program. However, as of January 30, 2009, Program management had neither finalized the logistics and maintenance plans nor obtained an agreement for the transfer of the Shuttle Carrier Aircraft. Settlement of these actions should provide SOFIA Program management the information needed to better estimate the cost for aircraft spare parts and maintenance requirements. Although the transfer of the Shuttle Carrier Aircraft could save the Program approximately \$20 million in spare parts costs, the uncertainty over the exact retirement date of the Space Shuttle Program demands consideration and development of alternative spare parts plans. Similarly, completion of these plans should help in the development of a baseline from which management can monitor long-term cost and schedule performance.

SOFIA Program management did not have an effective cost control process because its monitoring process did not integrate cost with schedule. The Program's process monitored cost and schedule separately, and the process was ineffective because it measured cost performance against a cost baseline that was unreliable as reflected by an ever-increasing cost trend. Further, there was no evidence of an independent cost estimate being performed to validate the Program's cost estimates.

SOFIA Program management's cost and schedule monitoring process did not function in accordance with American National Standards Institute/Electronic Industries Alliance - 748 (ANSI/EIA-748), "Standard for Earned Value Management Systems," June 1998,<sup>1</sup> as required by NASA Procedural Requirements (NPR) 7120.5D, "NASA Space Flight Program and Project Management Requirements," March 6, 2007. The process also did not comply with the SOFIA Program Plan, July 10, 2007, which states that Earned Value Management (EVM) would be the primary tool employed to control and monitor cost performance of the SOFIA Program. Data for each work package in the process that Program management instituted pertain strictly to schedule and did not include cost estimates; therefore, Program management cannot quantify earned value and cost performance by work package.

SOFIA Program management did not obtain an ICE to validate SOFIA Program cost estimates—for total life-cycle cost or detailed work package cost estimates. An ICE can provide reasonable assurance that the cost baseline is reliable for use in an Earned Value

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<sup>1</sup> ANSI/EIA-748-B was published in June 2007.

Management System (EVMS) to measure cost performance. NPR 7120.5D requires that an ICE be performed following a program or project's formulation phase. The SOFIA Program is in the implementation phase and will continue in this phase until reaching Full Operational Capability in 2014. An objective ICE improves reliability of program cost estimates by serving as an independent validation of them. The SOFIA Program has a history of increasing life-cycle cost estimates. An ICE would provide NASA management with a benchmark to assess the reasonableness of the Program's cost estimates. Reliable cost estimates are also vital to the proper functioning of an EVMS.

The Program has not implemented EVMS nor conducted an ICE because SOFIA Program management has emphasized meeting near-term schedule milestones and has chosen not to expend resources in those other areas. As a result, Program management did not have an adequate EVMS to provide reliable earned value and early identification of performance trends and variances from the management plan.

We also found that cost control measures were lacking at the contract level. SOFIA Program management did not incorporate "cost control" as a performance evaluation factor in two cost-plus-award-fee (CPAF)<sup>2</sup> contracts. The NASA supplement to the Federal Acquisition Regulation (FAR), NASA FAR Supplement (NFS) Version 04.0, November 1, 2004, requires that CPAF contracts include a cost control evaluation factor worth no less than 25 percent of the total weighted evaluation factors. The SOFIA Program's contracting officer stated that cost control factors were included as sub-criteria of the Business Management evaluation factor. We evaluated those sub-criteria in the contracts' Award Fee Determination Plans and NASA's award fee cover letters to the contractors. Our evaluation of the cost control sub-criteria contained within the Business Management evaluation factor showed that the sub-criteria related to cost control did not add up to the 25 percent weight requirement. In addition, the award fee cover letters to the contractors did not address cost control performance, as required by NFS.

We concluded that SOFIA Program management deemphasized the importance of cost control, which negated its effectiveness, did not incentivize the contractors to control costs, and emphasized meeting near-term schedule milestones without adequate regard for controlling cost. Consequently, NASA expended \$233,600 of Government funds for award fees that did not meet NFS requirements and, therefore, have been made without appropriate basis. Further, if Program management does not change the evaluation criteria in the Award Fee Determination Plans to meet the requirement that cost control accounts for no less than 25 percent of the total weighted evaluation factors, future award fees could potentially be awarded without the appropriate emphasis on cost control.

**Recommendations.** In our February 25, 2009, draft of this memorandum, we recommended that SOFIA Program management complete the actions required to address

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<sup>2</sup> Defined by FAR 16.305, "Cost-plus-award-fee contracts," as a cost-reimbursement contract that provides for a fee consisting of (a) a base amount (which may be zero) fixed at inception of the contract and (b) an award amount, based on a judgmental evaluation by the Government, sufficient to provide motivation for excellence in contract performance.

long-term aircraft servicing and spare parts concerns, which includes finalizing logistics and maintenance plans, the Shuttle Carrier Aircraft transfer agreement, and alternative spare parts plans based on various projected Space Shuttle Program retirement dates to estimate the impact on the Program budget. Program management should also fully implement a program level EVMS that complies with ANSI/EIA-748 guidelines, which includes developing cost estimates by work packages; using a third party, ICE review to validate those estimates; and incorporating the estimates into the EVMS. In addition, SOFIA Program management should work with the contracting officer to modify the existing Award Fee Determination Plans for all SOFIA CPAF contracts and establish a cost control evaluation factor that is no less than 25 percent of the total weighted evaluation factors. Implementing these recommendations will provide Program management with the tools required for long-term success, bring award fee contracts into compliance with NFS, and prevent NASA from paying potentially unwarranted award fees.

**Management's Comments and Auditor Response.** In commenting on the draft of this memorandum (see Enclosure 2), NASA management requested clarification on two issues and generally concurred with the recommendations; we consider all but two recommendations resolved.

The Associate Administrator for the Science Mission Directorate requested that we revise the 2008 dollar projection in Table 1 to more accurately compare cost growth with the 1997, 2000, and 2003 projections. In addition, the Associate Administrator stated that the 2008 dollar figure in the draft memorandum reflected full-cost accounting<sup>3</sup> and the projections for prior years did not. We agreed to revise the 2008 projection and incorporated the suggested change, which we calculated to be \$840 million, to provide a more accurate comparison between the milestone represented in the 2008 projection and the milestone represented in the prior year projections and included a footnote to clarify the difference. However, based on the information contained in the NASA Fiscal Year (FY) 2009 Budget Estimate, we disagreed that the 2008 dollar projection in our draft memorandum was full cost. After further discussions with Science Mission Directorate personnel and comparison with current budget estimates, it was agreed that the draft memorandum 2008 dollar projection was not full cost.

NASA management also stated that the draft of this memorandum implied that the SOFIA Program overpaid the award fee by \$233,600 on the two CPAF contracts and asked for clarification. There was no implication of an overpayment intended. However, cost control accounted for less than 25 percent of the total weighted evaluation factors in the Award Fee Determination Plans. Therefore, we calculated that \$233,600 of the \$1,377,078 total award fee paid was not in compliance with NFS requirements. Had cost control accounted for the required 25 percent of the total weighted evaluation factors, the contractors could have earned more or less than the actual award fee paid.

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<sup>3</sup> The full cost of a project is the sum of all direct costs, indirect costs (including civil service personnel costs), service costs, and Center Management and Operations costs associated with the project.

The Associate Administrator concurred with the intent of our recommendation to determine the disposition of the Shuttle Carrier Aircraft (Recommendation 1) and concurred with our recommendations to complete the maintenance and logistics plans (Recommendation 2.a), complete an ICE (Recommendation 3), and modify the CPAF contracts to comply with NFS requirements (Recommendation 4.a). The recommendations are resolved and will be closed upon completion and verification of management's corrective action.

The Associate Administrator's comments did not specifically address our recommendation to ensure that contractor cost control performance is explicitly communicated in future contractor performance evaluations (Recommendation 4.b). In addition, he partially concurred with Recommendation 2.b, to fully implement EVMS, stating his belief that the program is in compliance with NPR 7120.5D and welcoming further discussion to better understand our concerns and discuss implementation. We maintain that the system in place for the SOFIA Program is not in compliance with the NPR or the SOFIA Program Plan. Specifically, while the SOFIA Program Plan cites the ANSI/EIA-748 EVM principle of integrating cost and schedule at the work package level, the system in place only monitors cost at the Program's top level without integrating cost and schedule at the work package level.

We have begun discussions with Science Mission Directorate personnel and made a commitment to work with SOFIA Program management to further discuss the implementation of an effective EVMS that complies with NPR 7120.5D and the SOFIA Program Plan. We request that the Associate Administrator for the Science Mission Directorate provide additional comments on Recommendations 2.b and 4.b in response to our final memorandum by April 30, 2009.

### ***Background***

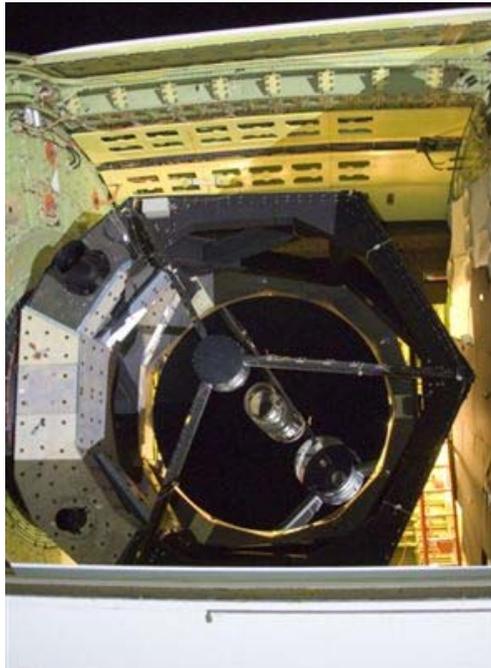
SOFIA is an airborne observatory that will study the universe in the infrared spectrum. It is a continuation of NASA's Kuiper Airborne Observatory, which was a modified C-141 aircraft with a 36-inch reflecting telescope that flew from 1974 to 1995. Designed within the airframe of a Boeing 747SP (see Figure 1), SOFIA contains an internally mounted 2.5-meter telescope (see Figure 2) that will be exposed to the night sky via a specially designed cavity door system. The observatory is designed to serve as a laboratory for developing and testing astronomical instrumentation and detector technology. It is intended to enable a wide variety of astronomical science observations not possible from other Earth- and space-based observatories.

**Figure 1. SOFIA Flying Observatory**



Source: NASA Dryden Flight Research Center Photo Collection, ED08-0067-19, March 10, 2008.

**Figure 2. SOFIA Airborne Observatory's 2.5-Meter Telescope**



Source: NASA Dryden Flight Research Center Photo Collection, ED08-0296-14, November 12, 2008.

The advantages of SOFIA over other observatories are its mobility and flexibility. SOFIA can be flown from and to any part of the globe to achieve the optimal viewing position. It is designed to fly at altitudes above 40,000 feet—above the water vapor in the lower atmosphere that blocks light in the sub-millimeter and far-infrared spectrum

from being observed by ground-based telescope systems. SOFIA is designed to incorporate and test a wide range of astronomical instruments, such as cameras and spectrographs, and change them as required by the mission. It can also incorporate instrument improvements and upgrades, thus allowing it to react quickly to new technology improvements.

The SOFIA Program formulation started in 1991; development was initiated in December 1996 by a cooperative agreement between NASA and the *Deutsches Zentrum für Luft- und Raumfahrt* (DLR), German Aerospace Center. Under the terms of the cooperative agreement, DLR would receive 20 percent of the observation time after the observatory goes into full operation. In return, DLR provided the telescope assembly, aircraft engine upgrades, aircraft repainting, and two science instruments. When SOFIA is in full operation, DLR would provide mission support staff, fuel costs for German flights, and share 20 percent of the operation costs. The most recent estimate of DLR's fiscal contribution was approximately \$323 million.<sup>4</sup>

**Events Leading to a Change in Program Management.** In August 1995, the Associate Administrator for Space Science<sup>5</sup> determined that SOFIA's procurement should be privatized because privatization would offer the science community the same service that NASA could provide at lower costs or better service at the same life-cycle cost. Further, he determined that it was in NASA's best interest to select a single private sector entity to develop and operate SOFIA. The Program's initial development cost was estimated at \$265 million. In 1996, NASA awarded a prime contract to University Space Research Association for \$311 million, which included \$167 million to develop the SOFIA aircraft. University Space Research Association was responsible for the entire management, development, implementation, and operation of the SOFIA aircraft, and subcontracted L-3 Communications Corporation (L-3) for aircraft modification and United Airlines for aircraft maintenance. The airborne observatory's initial estimated delivery date was 2001.

As early as 1998, the Program began to experience schedule delays. Cost overruns were evident as early as 2000. In September 2003, United Airlines declared bankruptcy and divested itself from the Program. L-3 assumed aircraft maintenance responsibilities by subcontracting this effort to Leading Edge. In November 2004, an Independent Cost, Schedule, and Management Review found that the Program's organizational structure was "not conducive to an effective flight mission integration process." Specifically, the Review found that, organizationally, NASA management was "hands off" and only maintained an oversight function. There were overlaps among NASA, prime contractor, and subcontractor responsibilities with no clear lines of authority. The review also found that the systems engineering function was not cohesive. Distribution of cost, schedule, and technical expertise among the various organizations made management of the SOFIA

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<sup>4</sup> Estimate made by the SOFIA Option Review Team on April 25, 2006.

<sup>5</sup> In NASA's 2005 reorganization, Space Science and Earth Science Enterprises combined into the Science Mission Directorate.

Program difficult. In addition, the Review reported technical problems with the telescope assembly and continuing problems with the cavity door. The reviewers also questioned the reliability of the Program's cost estimate, specifically concerning the preparation of the SOFIA aircraft for an Operational Readiness Review by January 2005.

In February 2005, NASA issued a contract stop work order due to aircraft maintenance mishaps and quality assurance issues. Work resumed on the aircraft after L-3 replaced the lower tier subcontractor responsible for aircraft maintenance and NASA assumed oversight of the quality assurance process.

In February 2006, NASA withheld Program funding for FY 2007 and forward until an independent study was performed to assess the Program's status and options for continuation. A SOFIA Option Review Team (SORT) was formed and presented its findings and recommendations to NASA's Science Mission Directorate in April 2006. In June 2006, NASA reinstated the Program with a significantly reorganized Program management structure.<sup>6</sup>

**Program Management Changes and Improvements.** As a result of the SORT recommendations, NASA took control of management for the SOFIA Program, assigning that function to Dryden Flight Research Center (Dryden); reorganized the Program into two major projects—Platform (Aircraft and Telescope Assembly) and Science and Operations. The projects were assigned with respect to Center technical expertise—the Platform Project to Dryden and the Science and Operations Project to Ames Research Center. Dryden assumed responsibility for maintaining the aircraft and overseeing the quality assurance and systems engineering functions.

In May 2006, NASA decided to certify the aircraft using the NASA research aircraft certification process; thus, NASA no longer relied on the contractor to maintain and certify the aircraft to meet commercial airworthiness requirements. The Program renegotiated previous contracts and subcontracts and converted them into separate support contracts. This maximized and improved NASA's control of the Program's direction, schedule, and performance.

SOFIA Program management plans to demonstrate SOFIA's potential before full operation, which is scheduled to begin in 2014. Demonstrations are planned to show SOFIA's science capabilities progressively in two stages—initiation of science flights in August 2009 and Limited Operational Capability in August 2011. Initiation of science flights will demonstrate that the aircraft is safe to operate with the door open and that the telescope is able to track objects. The initial flights are intended to evaluate the telescope and the instrument observatory capabilities. Flights will have limited duration and fly within the vicinity of Dryden.

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<sup>6</sup> After reviewing the SORT report, the NASA Administrator announced a plan to continue SOFIA, with some significant management changes. He indicated that NASA's Program Management Council concluded that no significant technical challenges remained. However, he stated that a team needed to be in place having a greater level of experience with research aircraft. As a result, the Dryden Flight Research Center would become lead for development and flight tests of SOFIA.

After these initial science flights, Program management plans to increase flight duration and frequency over time to demonstrate the capability of the observatory and its scientific value. In 2011, upon reaching the Limited Operational Capability milestone, the Program will begin science research within the full flight envelope and full range from Palmdale,<sup>7</sup> operate with all subsystems fully functional, and initiate observations interleaved with progressive telescope performance evaluations and tuning improvements. Upon reaching Full Operational Capability in 2014, SOFIA Program management plans for 960 observing hours a year for 20 years.

### ***Risk Management and Quality Assurance Processes Were Adequate***

Our review of the Program's internal controls found that Program management had established adequate quality assurance processes in overseeing contract performance and a risk assessment process that complied with NPR 8000.4, "Risk Management Procedural Requirements," April 25, 2002. Program management effectively recognized, mitigated, and implemented strategies to minimize disruptions to the Platform Project schedule. For example, Government quality assurance personnel provided adequate oversight of the contractor's performance in identifying manufacturing defects associated with the upper rigid door insulation panels. In addition, Program management had an adequate process in place to assess the risk of postponing the installation of the upper rigid door insulation panels. The proposed strategy was supported by sufficient technical evaluations, and decisions were consistent with the results of those evaluations.

### ***Long-Term Planning and Program Performance Monitoring Could Be Improved***

NASA management had taken necessary initiatives to correct prior SOFIA Program management issues. However, SOFIA Program management needs to complete actions essential for the long-term viability of the aircraft and improve cost controls by fully implementing EVMS at the program and project level. To support full EVMS implementation, SOFIA Program management needs to estimate cost by work package and validate these estimates using an independent cost estimate.

**Aircraft Long-Term Servicing.** We found that SOFIA Program management had taken some proactive steps toward securing spare parts for SOFIA. In September 2008, Program management purchased an inoperable Boeing 747SP aircraft from Transatlantic International Airline for \$1.25 million and was in the process of dismantling the plane for spare parts. In addition, in January 2009, Dryden's Director submitted an internal NASA request to obtain the two Shuttle Carrier Aircraft after Space Shuttle Program retirement. The two Shuttle Carrier Aircraft are Boeing 747-100 model aircraft, similar to the Boeing 747SP and could be cannibalized for their spare parts.

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<sup>7</sup> The SOFIA aircraft was moved to the Los Angeles/Palmdale Regional Airport at Palmdale, California, 26 miles south of Dryden, in January 2008.

Program management estimated that obtaining the eight Shuttle Carrier Aircraft engines could result in lowering SOFIA's procurement costs by \$16 million (estimated at \$2 million for each engine). Further, transferring the two Shuttle Carrier Aircraft would preclude the expenditure of about \$2.5 million in acquisition costs for another two aircraft (based on the \$1.25 million spent to acquire the inoperable aircraft). Program management also estimated that the three aircraft (the inoperable aircraft and the two Shuttle Carrier Aircraft) would provide between 50 percent and 75 percent of the critical parts required (an estimated value of \$4 million to \$5 million). Conservatively, by acquiring the Shuttle Carrier Aircraft, the Program could potentially avoid spending \$20 million to obtain similar spare parts.

NASA and SOFIA Program management need to complete the actions initiated to address the long-term aircraft servicing concerns. As of January 30, 2009, the request from the Dryden Director to the Assistant Administrator for Infrastructure to transfer the Shuttle Carrier Aircraft had not been approved. Although a timely agreement would provide Program management with information needed to plan for acquisition requirements and potentially make funding available for other Program requirements, as of January 2009, Congress and the new Administration were contemplating various space policy options that could delay the Space Shuttle Program's retirement date by up to 5 years, from 2010 to 2015. Program management should develop alternative plans for supplying SOFIA with the spare parts needed.

Although the Program had a team in place to determine aircraft maintenance and spare parts requirements, as of January 30, 2009, there was no written draft of the maintenance plan and the draft of the integrated logistics plan was not sufficiently developed for our review or evaluation. This is a concern because Program management identified that the spare parts for this type of aircraft will be scarce in the future. The Boeing 747SP is a special performance version of the Boeing 747-100 with a limited production of only 45 aircraft. As time passes, the other Boeing 747SP aircraft will deteriorate and, therefore, the parts unique to the 747SP may not be usable as replacements or spares. This may have a severe impact on the serviceability of the SOFIA aircraft as it approaches the latter part of its 20-year operational life cycle.

NASA Policy Directive (NPD) 7500.1B, "Program and Project Logistics Policy," September 12, 1997, requires that programs apply the integrated logistics support engineering and management concepts and techniques to all phases of the program or project cycle to ensure the new or upgraded system will be economically supported throughout its planned life cycle. NPR 7120.5D requires that, during Phase D (implementation), the Project Manager and the project team establish and maintain an integrated logistics support capability, including spares, ground support equipment, and system maintenance and operating procedures, in accordance with the project's logistics plan. As of January 30, 2009, Program management had not completed the integrated logistics plan. Program management expects to complete the maintenance plan, which will identify inspection and maintenance requirements for the aircraft, by May 2009. Finalizing these plans should provide documented spare parts and maintenance

requirements and a basis for estimating requirements to ensure that there will be sufficient funding in the Program's budget to support these requirements.

**Program Cost Control Monitoring.** SOFIA Program management did not have an effective cost control process because its monitoring system did not integrate cost with schedule. Program management's process of monitoring cost and schedule separately was ineffective because it was measuring cost performance against a cost baseline that was unreliable as reflected by an ever-increasing cost trend. Further, there was no evidence of an independent cost estimate being performed to validate the Program cost estimates. Program management can improve cost and schedule monitoring by estimating cost by work package, validating the Program cost estimates through an independent cost estimate, and fully implementing an integrated EVMS as required by NPR 7120.5D and the SOFIA Program Plan.

SOFIA Program management did not have a fully implemented EVMS that allowed for integrating cost with schedule. When fully implemented, the EVMS compares the value of work completed during a given period with the work scheduled to be completed for that period, which is more than simply comparing budgeted costs to actual expenditures and determining whether or not schedule milestones have been met. Therefore, an accurate, valid, and current performance management baseline is needed to perform useful EVM analyses, as discussed by the Government Accountability Office.<sup>8</sup> Accordingly, a planned value (i.e., budget) is needed for each scheduled element of work. As these elements of work are completed, their target planned values are "earned." As work progress is quantified, the earned value becomes a metric against which to measure both what was spent to perform the work and what was scheduled to have been accomplished, allowing the system to isolate and quantify schedule variance and cost variance separately.<sup>9</sup> These variances can inform management as to whether the program is progressing on schedule and within budget, allowing the program manager to address potential cost overruns and schedule delays prior to expending the entire budget.

Instead of employing a fully implemented EVMS, SOFIA Program management had been monitoring cost performance by comparing actual costs against budgeted costs at the Program level instead of the work package level. Schedule performance was monitored separately by comparing completed milestones against those planned. However, the Program's total actual cost was not an indication of work progress, only an indication of hours and money spent. Further, the SOFIA Program's monitoring process did not integrate cost with schedule that would enable identification of progress at the work package level. Therefore, SOFIA Program management lacked the ability to quantify cost and schedule variances at the work package level and identify signs of potential cost and schedule problems.

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<sup>8</sup> NASA: "Lack of Disciplined Cost-Estimating Processes Hinders Effective Program Management" GAO-04-642, May 2004), Appendix IV.

<sup>9</sup> American National Standards Institute/Electronic Industries Alliance ANSI/EIA-748-B, "Earned Value Management System."

**Lack of Cost Detail for Full EVMS.** SOFIA Program management had a system in place similar to EVMS, but it lacked the cost estimates by work package needed to fully implement the system and have it function as intended. SOFIA Program management had a full-time EVMS subject matter expert assigned to the Program, used Microsoft Project<sup>10</sup> to load schedule information by work package, and acquired Deltek Cobra software<sup>11</sup> to collect data from Microsoft Project and generate a cost performance schedule. However, Microsoft Project was loaded with schedule information only and, therefore, was limited to monitoring only schedule performance. There was no estimated cost by work package; therefore, the system cannot generate cost performance results and facilitate variance analyses. The SOFIA Program's performance monitoring process conformed neither to the EVM principles nor to the SOFIA Program Plan.

NPR 7120.5D requires EVMS be implemented in compliance with ANSI/EIA-748 for projects as well as contracts exceeding \$20 million. ANSI/EIA-748 guidelines for planning, scheduling, and budgeting include identifying the authorized work in discrete work packages and establishing budgets for this work in terms of dollars, hours, or other measurable units. The SOFIA Program Plan, Section 3.1, "Technical, Schedule, and Cost Control Plan," July 10, 2007, states that EVMS would be the primary tool employed to evaluate cost performance of the Program. The Plan called for control accounts to be established based on the work breakdown structure and management structure of the Program. A control account manager would be responsible for establishing the Integrated Master Schedule, which in combination forms the program's performance measurement baseline; the latter was typically referred to as planned value, or budgeted cost of work scheduled.

SOFIA Program management did not have a fully implemented EVMS because, in part, Program management did not estimate cost at the work package level. Program management emphasized meeting near-term schedule milestones and questioned whether committing resources to implement EVMS would be beneficial to the Program. Specifically, according to SOFIA Program personnel, by the time EVMS could be fully implemented, management anticipated that the Program would be late in the implementation phase, when most of the technical issues should have been resolved. However, SOFIA Program management did not conduct any formal study to evaluate the costs and benefits associated with these EVMS implementation concerns.

NPR 7120.5D requires that EVMS be implemented during Phase C (implementation). The Program is in the implementation phase, which is not scheduled to end until SOFIA reaches Full Operational Capability, which is anticipated in 2014. Further, the Program currently has expended approximately \$639 million of the \$1.1 billion budgeted for formulation and implementation phases. There is still a significant portion of the budget

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<sup>10</sup>Microsoft Project is a project management software program developed by the Microsoft Corporation. It is designed to assist project managers in developing plans, assigning resources to tasks, tracking progress, managing budgets and analyzing workloads.

<sup>11</sup>Deltek Cobra, developed by Deltek, Inc., is an enterprise system for managing project costs; measuring earned value; and analyzing budgets, actuals, and forecasts.

remaining (\$469 million) prior to achieving Full Operational Capability. In perspective, the initial development estimate was \$265 million to reach the Operational Readiness Review,<sup>12</sup> which grew to \$840 million to obtain Limited Operational Capability (see Table 1 on page 14). In addition, NASA budgeted another \$233 million to reach Full Operational Capability. In light of the Program's history of cost underestimation and the lack of measurable earned value, the remaining estimated costs to attain Full Operational Capability should be monitored in accordance with requirements to prevent further cost growth or schedule delay.

**Unreliable Total Cost as a Comparative Baseline.** SOFIA Program management's cost monitoring process measured performance against total cost estimates. This is ineffective because the SOFIA Program has a history of ever-increasing, unreliable life-cycle cost estimates. A reliable cost baseline that is accurate, valid, and current is required for EVMS to provide meaningful performance analyses. An ICE has the ability to reconcile and validate SOFIA Program management's cost estimates—by work breakdown structure and for total life-cycle cost.

NPR 7120.5D states that the governing Program Management Council (PMC), which is the Agency PMC for the SOFIA Program, has “the responsibility of periodically evaluating the cost, schedule, risk, technical performance, and content of a program or project under its purview.” One tool to support this evaluation is the ICE. The NPR states that an ICE should be performed by the end of the formulation phase and performed by an organization outside of the program office. The estimate would be bound by the program scope (total life cycle through all phases), schedule, technical content, risk, ground rules, and assumptions and be conducted with objectivity and the preservation of the cost estimate integrity.

Validation of the program cost estimate by ICE is particularly important because the SOFIA Program had a history of growing cost and schedule projections, as shown in Table 1.

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<sup>12</sup>Comparable to the Limited Operational Capability milestone, the Operational Readiness Review denoted the time when all instruments would be completed and initial science observations would commence. Refinement of telescope performance would be performed in the 3 years following in order to reach full system performance capability (Full Operational Capability).

<b>Table 1. History of Program Cost Projections</b>			
<u>Year of Projection</u>	<u>Projected Budget for Initial Program Development</u>	<u>Projected Date for Operational Readiness Review</u>	<u>Note</u>
1997	\$ 265 million	September 2001	1
2000	301 million	December 2002	1
2003	373 million	March 2005	1
2008	840 million*	August 2011	2

Note 1: Based on SOFIA Independent Cost, Schedule, and Management Review of October 2004.  
Note 2: Dollar projection based on the NASA FY 2009 Budget Estimate; date is the Limited Operational Capability milestone.  
\* Does not include \$35 million for formulation.

As Table 1 shows, NASA projected in 1997 that the SOFIA Program would have a \$265 million budget and that operations would begin in September 2001. In 2000, 3 years later and just 1 year before the initial projected operation date, the cost and schedule estimate was revised to increase the budget by \$36 million (to \$301 million) and delay operations by one year (to 2002). In 2003, 1 year after the second projected operation date, the budget estimated was increased by another \$72 million and operations were delayed another 3 years. The latest projection, in 2008, increased the budget by \$467 million (125 percent of the year 2003 budget) and delayed the schedule by another 6 years. This reflected an overall budget increase of \$575 million (217 percent) and a 10-year schedule delay to begin limited operations.

The continuous upward trend of the SOFIA Program's cost projections suggests that total costs had been underestimated, and the schedule suffered comparably. In addition, we did not find any detailed work package estimates that would substantiate the cost estimates shown in Table 1, and there was no ICE performed to validate the total costs. Considering the Program's history of cost growth, total estimated costs have been an unreliable cost baseline and would not provide meaningful comparison criteria of cost performance.

### ***Contractor Cost Control Evaluation Could Be Improved***

We found that SOFIA Program management had two CPAF contracts that did not comply with NFS 1816.405-274, "Award Fee Evaluation Factors." Specifically, both contracts did not include cost control as an award fee evaluation factor. Furthermore, NASA did not clearly communicate to the contractors their cost control performance as required by NFS 1842.15, "Contractor Performance Information."

SOFIA Program management awarded two CPAF contracts that did not comply with NFS requirements of evaluating contractors' cost control performance. On

September 15, 2006, SOFIA Program management awarded MPC Corporation (MPC) a contract to support the aircraft's Cavity Door Drive System (CDDS). On February 8, 2007, SOFIA Program management awarded L-3 a contract to modify the aircraft and support the aircraft's Mission Communications Control System. Both the CDDS and Mission Communications Control System are essential to the success of the SOFIA Program. Both tasks were on the Program's critical path, which meant that any delay in these two tasks would also delay the program and affect cost. The MPC contract value was \$6.8 million of which \$547,000 was available for the award fee. The L-3 contract value was \$24.7 million of which \$2.3 million was available for the award fee. As of September 30, 2008, NASA had awarded approximately \$357,000 in award fees to MPC and \$1 million to L-3.

NFS 1816.405-274 states:

Evaluation factors will be developed by the contracting officer based upon the characteristics of an individual procurement. Normally, technical and schedule considerations will be included in all CPAF contracts as evaluation factors. **Cost control shall be included as an evaluation factor in all CPAF contracts. When explicit evaluation factor weightings are used, cost control shall be no less than 25 percent of the total weighted evaluation factors.** [emphasis added] The predominant consideration of the cost control evaluation should be a measurement of the contractor's performance against the negotiated estimated cost of the contract.

A CPAF contract is intended to motivate excellent contractor performance in areas such as quality, timeliness, technical ingenuity, and cost-effective management. Cost-effective management is an essential part of contractor performance. The contractor's success in controlling costs must be measured against contract-estimated costs, and not against budgetary or operating plan costs.<sup>13</sup> SOFIA Program management justified the use of CPAF to provide performance incentive for the contractors and to ensure expeditious performance to avoid additional program delays. SOFIA Program management's justification and evaluation distribution were consistent with emphasizing schedule over costs.

**Lack of Explicit "Cost Control" Evaluation Factor.** Both contracts' Award Fee Determination Plan had no cost control evaluation factor, which is expressly required by NFS. As of August 2008, both MPC and L-3 contracts' Award Fee Determination Plans showed three evaluation factors: Schedule, Technical, and Business Management. For both contracts, Schedule and Technical Performance were the most heavily weighted evaluation factors—75 percent of the award fee pool. Business Management performance carried 25 percent of the award fee pool.

The SOFIA Program Contracting Officer was aware of the NFS requirement that cost control be an evaluation factor and asserted that cost control factors were adequately captured within the Business Management evaluation factor. The contracting officer also

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<sup>13</sup>Award Fee Contracting Guide, June 27, 2001, Section 3.6.3, "Scoring of Cost Control."

indicated that increasing the cost control weights would decrease the Program's emphasis on Schedule and Technical evaluation factors.

We determined that some sub-criteria of the Business Management evaluation factor were related to cost control. However, the weight of those sub-criteria did not add up to the 25 percent requirement. Table 2 lists the Business Management evaluation factor sub-criteria and the relative weight percentages of each.

<b>Table 2. Sub-Criteria for Business Management Evaluation Factor</b>				
<u>No.</u>	<u>Note 1</u>		<u>Note 2</u>	
	<u>MPC Corporation</u>	<u>Weight</u>	<u>L-3</u>	<u>Weight</u>
1	Financial data shall be timely, current, accurate, and complete.	5 percent	Financial data shall be timely, current, accurate, and complete.	
2	Cost incurrence notification is timely.	2 percent	Cost incurrence notification is timely.	
3	Cost overruns are avoided or minimized. MPC provides timely and detailed identification and notification to the contracting officer and contracting officer's technical representative of cost risks and the potential for overruns.	3 percent	Cost overruns are avoided.	
4	Supports and participates in Program Earned Value Management System. Uses EVM to manage Requirements, Schedule, and Budget to produce a quality product. Reports EVM status as required by the contract.	3 percent	Contract deliverables satisfy requirements.	Not Specified
5	Provides an effective system for assuring availability of materials and parts.	2 percent	Provides an effective system for assuring availability of materials and parts.	
6	Coordination of activities and management of internal and external changes that affect the program.	4 percent	Meets Small Disadvantaged Business subcontracting goals.	
7	Ability to work to baseline. Timely identification and mitigation of risk to baseline cost estimates. Strategizing on ways to maintain or lower costs.	6 percent	Proposals submitted are timely, current, accurate, and complete.	
<b>Total</b>		<b>25 percent</b>		<b>25 percent</b>
Note 1: From MPC contract's Award Fee Determination Plan, September 20, 2007.				
Note 2: From L-3 contract's Award Fee Determination Plan, July 23, 2007.				

For the MPC contract, we found that there were detailed evaluation worksheets for MPC contract award fee periods 1 through 3. Those worksheets showed that the Business Management evaluation factor was divided into three categories: Documentation, Cost Control, and Contract Management. The Cost Control category consisted of Business Management sub-criteria numbers 2, 3, and 7 (see Table 2). These three sub-criteria had a total weight of 11 percent of the award fee pool, which was far less than the 25 percent required by NFS.

We considered the L-3 contract's Business Management sub-criteria 2 and 3 of the Award Fee Determination Plan to be cost control related. However, there was no weight assigned to any of the seven sub-criteria. Evaluation results showed that the score given for the Business Management evaluation factor was a straight average of the sub-factors evaluated. Thus, all seven sub-criteria carry equal weight. Therefore, sub-criteria 2 and 3 combined carried about 7 percent weight, which was less than the 25 percent requirement specified by NFS.

**Ineffective Cost Control.** By assigning less than the minimum 25 percent weight as required by NFS, we concluded that Program management had significantly deemphasized the importance of cost control and negated its effectiveness.

The MPC contract had 11 percent of the total weight allotted to cost control, which gave minimum incentive for the contractor to control cost because a poor cost control performance rating can easily be offset by two or three other non-cost control factors. For example, as long as MPC met schedule milestones (which carried a 40 percent weight or about 4 times cost control weight), that would negate any poor cost control performance. Similarly, the L-3 contract had 7 percent of the total weight allotted to cost control, which was a small fraction (about one-fourth) of the 25 percent requirement. In this case, not only meeting schedule would negate any poor cost control performance, poor cost control performance could just as easily be offset by meeting Small Disadvantage Business subcontracting goals, and submitting timely, current, accurate, and complete proposals.

The low percentage weighting deemphasized the importance of controlling cost, minimized the effectiveness of cost control, and gave the contractors minimal incentive to do so. As a result, Program management did not adhere to NFS requirements and \$49,957 (14 percent) of MPC's award fee and \$183,643 (18 percent) of L-3's award fee represented an ineffective use of Government funds (see Table 3). Further, if Program Management does not change the Award Fee Determination Plan evaluation criteria to meet the 25 percent cost control requirement, future award fees<sup>14</sup> could be awarded without appropriate emphasis on cost control.

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<sup>14</sup>As of September 30, 2008, a total award fee of \$149,138 and \$1,102,348 was available to MPC and L-3 respectively for the remaining evaluation periods (one period remaining for MPC and two for L-3) of the contracts.

<b>Table 3. Summary of Paid Award Fees</b>					
<u>Award Fee Period</u>	<u>Available Award Fee</u>	<u>Performance Evaluation</u>	<u>Paid Award Fee</u>	<u>Unaccounted Cost Factor</u>	<u>Award Fee Paid Not in Compliance with NFS Requirement</u>
MPC Corporation					
Period 1	\$124,363	90 percent	\$111,927	14 percent	\$15,670
Period 2	124,363	95 percent	118,145	14 percent	16,540
Period 3	<u>149,137</u>	85 percent	<u>126,766</u>	14 percent	<u>17,747</u>
Subtotal	\$397,863		\$356,838		\$49,957
L-3 Communications Corporation					
Period 1	\$ 649,614	79 percent	\$ 513,196	18 percent	\$ 92,375
Period 2	<u>551,135</u>	92 percent	<u>507,044</u>	18 percent	<u>91,268</u>
Subtotal	\$1,200,749		\$1,020,240		\$183,643
<b>Total</b>	<b>\$1,598,612</b>		<b>\$1,377,078</b>		<b>\$233,600</b>

**Cost Control Performance Was Not Communicated.** The Performance Evaluation Board (PEB) finding memorandum did not specifically communicate cost control performance. Per NFS 1842.1501, “Communication with contractors are vital to improved performance and this is NASA’s primary objective in evaluating past performance.” In the case of the MPC contract, which included “Cost Control” as one of the contract’s evaluating categories under “Business Management Criteria,” none of the PEB findings referenced cost control. The finding memorandum’s narratives were too broad to determine whether the criteria met the desired outcomes relating to cost. For example, under the PEB findings for MPC’s Award Fee Period 2, the contractor received a rating of “Excellent” and a score of 99.2 percent for Business Management. There was no mention of cost control or positive factors leading to cost mitigation. The PEB finding for Business Management stated:

Overall, MPC’s program and business management for the SOFIA CDDS contract has been highly professional, motivated, responsive, and of excellent quality. Again MPC’s willingness to work closely with its NASA counterparts and its responsiveness to requests from the COTR [contracting officer’s technical representative] and Contracting Officer has been excellent.

We also found that the SOFIA Program contracting officer informed contractors of their award fee determinations by sending letters and attaching their respective PEB finding memorandum for the award fee period. However, neither the cover letter nor the PEB finding memorandum gave the contractors any feedback on their cost control

performance. Consequently, the scores given and the award fee paid to the contractor may not accurately reflect whether the contractor had prudently managed cost while meeting contract requirements. Without indicating areas of emphasis or evaluating cost control performance against desired outcomes, NASA had no assurance that the contractor would be motivated to ensure that cost control objectives were being met.

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

**Recommendation 1.** We recommended that the Assistant Administrator for the Office of Infrastructure and the Director, Dryden Flight Research Center, finalize the agreement to transfer the two Shuttle Carrier Aircraft after the Shuttle Program retirement.

**Management's Response.** The Associate Administrator for the Science Mission Directorate concurred with the intent of the recommendation, stating that the Office of Infrastructure will coordinate the request to transfer the aircraft with the other NASA stakeholders and, if the transfer is delayed or not approved, the SOFIA Program would purchase one or more additional 747SP airframes for spare parts as a back-up plan.

**Evaluation of Management's Response.** Management's planned action is responsive. The recommendation is resolved and will be closed upon completion and verification of management's corrective action.

**Recommendation 2.a.** We recommended that the SOFIA Program Manager complete the logistics plan, to include the development of alternative spare parts plans based on various potential retirement dates of the Space Shuttle Program, and maintenance plan in a timely manner.

**Management's Response.** The Associate Administrator concurred, stating that the logistics plan is expected to be completed in the 4th quarter of 2009 and the updated maintenance plan by September 2009.

**Evaluation of Management's Response.** Management's planned action is responsive. The recommendation is resolved and will be closed upon completion and verification of management's corrective action.

**Recommendation 2.b.** We recommended that the SOFIA Program Manager fully implement the Earned Value Management System in compliance with NPR 7120.5D.

**Management's Response.** The Associate Administrator partially concurred with the recommendation, inviting further discussion to better understand the concerns raised in the report and discuss the implementation of EVMS. The Associate Administrator stated that he believed that SOFIA Program management complied with NPR 7120.5D and that the principles of EVM were implemented at the program level relative to program milestones in the form of monthly reports of milestones

accomplished versus the planned milestone and the cost of those milestones versus the planned cost. He stated that these comparisons, together with the integrated master schedule of major program and project milestones, provided insight into program performance regardless of who (NASA or DLR) performed specific activities. The Associate Administrator asserted that the approach was consistent with the participating Center's best practices as required in NPR 7120.5D.

**Evaluation of Management's Response.** Management's comments are partially responsive. The principle of EVM begins with the itemization of the project to finite work packages and continues with identifying the resources required to complete the individual packages, integrating resource requirements with schedule, monitoring progress by the summation of the packages, and analyzing the variances. SOFIA Program management demonstrated that understanding when the SOFIA Program Plan was developed. Section 3.1 of the Plan, "Technical, Schedule, and Cost Control Plan," states that the primary tool being employed to control cost performance on the program is EVM. The Plan includes a description of EVM procedures: "[c]ontrol accounts are established based on the WBS [work breakdown structure] and management structure of the program. Each control account has an assigned Control Account Manager (CAM) starting with the Program Manager at the program level and flowing down through both projects and their supporting tasks/work packages and related activities." Further, the Plan states that each CAM is responsible for establishing in the Integrated Master Schedule the resources for their respective accounts. The Integrated Master Schedule forms the Program's performance baseline. The Plan also established that this baseline would be the "budgeted cost of work scheduled." We disagree with SOFIA Program management's assessment that monitoring cost at the Program's top level without integrating cost and schedule at the work package level meets the principle of EVM as described in the Program Plan or its intended purpose of being a cost control mechanism.

The Associate Administrator also asserted that SOFIA Program management complied with NPR 7120.5D by implementing an approach that is consistent with the Center's best practice. Although NPR 7120.5D (paragraph 3.1.c of Appendix F) states that the project's EVM approach should be consistent with the participating Center's best practices, it also includes the following requirements:

- The project's EVM approach be in place by Key Decision Point (KDP) C (implementation phase) and implemented in Phase C through KDP E (the start of the operational phase).
- Project EVM reporting begin within 60 days after the start of Phase C.
- As a minimum, EVM principles, as defined by ANSI/EIA-748, apply from KDP C through KDP E, if the project's life-cycle cost is at or greater than \$20 million.

- If the project's primary NASA Center has a fully validated EVMS, the project must use that system rather than EVM principles.

Because Dryden does not have a fully validated EVMS and SOFIA Program management's system has not fully implemented the EVM principles as defined by ANSI/EIA-748, we maintain that the system is not in compliance with NPR 7120.5D, and this recommendation remains unresolved.

We will work with Program management to facilitate resolution of this recommendation. We request that the Associate Administrator reconsider his position and provide additional comments on the final memorandum.

**Recommendation 3.** We recommended that the Agency Program Management Council request an independent cost estimate to validate the SOFIA Program budget and life-cycle cost estimates.

**Management's Response.** The Associate Administrator for the Science Mission Directorate concurred and stated that an ICE is planned to be performed as part of the Standing Review Board work in early 2010.

**Evaluation of Management's Response.** Management's planned action is responsive. The recommendation is resolved and will be closed upon completion and verification of management's corrective action.

**Recommendation 4.a.** We recommended that SOFIA Program management coordinate with the SOFIA Program Contracting Officer to review and modify (if required) all cost-plus-award-fee contracts to ensure Award Fee Determination Plans explicitly reflect cost control as an evaluation factor with an evaluation weight no less than 25 percent of the total weighted evaluation factors.

**Management's Response.** The Associate Administrator partially concurred, stating that the Program will modify the two CPAF contracts to comply with regulations. He also requested clarification on our implication that the Program overpaid award fees by \$233,600.

**Evaluation of Management's Response.** Management's planned action is responsive. The recommendation is resolved and will be closed upon completion and verification of management's corrective action. There was no implication of an overpayment intended. Because cost control accounted for less than 25 percent the total weighted evaluation factors in the Award Fee Determination Plans, we calculated that \$233,600 of the \$1,377,078 total award fee paid was not in compliance with NFS requirements. Had cost control accounted for the required 25 percent of the total weighted evaluation factors, the contractors could have earned more or less than the actual award fee paid.

**Recommendation 4.b.** We recommended that SOFIA Program management coordinate with the SOFIA Program Contracting Officer to ensure that contractor cost control performance is explicitly communicated in future evaluations.

**Management's Response.** The Associate Administrator did not specifically address this recommendation.

**Evaluation of Management's Response.** We request that the Associate Administrator provide specific comments on this recommendation.

We request that the Associate Administrator for the Science Mission Directorate provide additional comments on Recommendation 2.b in response to this final memorandum. The additional comments should reevaluate SOFIA Program management's implementation of EVMS in respect to compliance with NPR 7120.5D requirements. In addition, we request a specific response to Recommendation 4.b, that contractor cost control performance is explicitly communicated in future contractor evaluations. We request that management provide the additional comments by April 30, 2009.

We appreciate the courtesies extended during our audit. If you have any questions, or need additional information, please contact Mr. Raymond Tolomeo, Science and Aeronautics Research Director, Office of Audits, at 202-358-7227.

signed

Evelyn R. Klemstine

2 Enclosures

cc:

SOFIA Program Executive  
SOFIA Program Manager

## **Scope and Methodology**

We performed this audit from April 2008 through February 2009 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 the audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We performed this audit at NASA Headquarters, Ames Research Center, and Dryden Flight Research Center. We reviewed Federal Acquisition Regulations (FAR) 16.305 , NASA FAR Supplement 1816.405, American National Standards Institute/Electronic Industries Alliance ANSI/EIA-748-B, NASA Policy Directive (NPD) 8730.5, NPD 8730.2B, NPR 8000.4, NPR 7120.5D, NPR 7500.1B, and NPR 5900.1.

We held meetings with SOFIA Program personnel to gain an understanding of the Program's management and operational structure. We reviewed Program documents and the Memorandum of Understanding between NASA and DLR to identify program goals, roles, and responsibilities. We reviewed the monthly and quarterly status review presentations and network diagram to track progress status.

We analyzed the Independent Cost, Schedule, and Management Review and the presentation provided to NASA management by SORT. We also interviewed NASA officials involved with these reviews to gain an understanding of prior program management and organizational structure issues and problems.

Relative to potential schedule delays attributed to product defects and delivery delays, we conducted follow-up inquiries and reviewed supporting documents pertaining to risk assessment and the quality control process.

To ensure that previously identified problems were being adequately addressed by Program management, we reviewed the Program's quality control structure and in-process quality control plans, as well as reviewed visit reports. To determine whether Program management had adequately implemented a process to limit further cost growths and schedule delays, we reviewed the program cost and schedule control process. We reviewed logistics and maintenance plans' spare parts requirements and acquisition strategies. We also reviewed the SOFIA Program's risk management process and assessed its compliance with NPR 8000.4.

We reviewed contracts and supporting documentation related to NASA's contracts with L-3 Communications and MPC Corporation to analyze the award fee plans. Specifically, we reviewed the contracts files, award fee documents, and fee determination plans to determine whether the award fee plans established adequate criteria for evaluating contractor performance and had been properly executed to achieve their desired outcomes.

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

**Review of Internal Controls.** We reviewed and evaluated internal controls associated with program cost and schedule controls. We also reviewed internal controls associated with the contract management. We identified control weaknesses in monitoring the cost and schedule and in evaluating the award fees for the CPAF contracts.

**Prior Coverage.** During the last 5 years, the Government Accountability Office (GAO) has issued two reports of particular relevance to the subject of this report. Unrestricted reports can be accessed over the Internet at <http://www.gao.gov>.

“NASA: Implementing a Knowledge-Based Acquisition Framework Could Lead to Better Investment Decisions and Project Outcomes” (GAO-06-218, December 21, 2005).

“NASA: Lack of Disciplined Cost-Estimating Processes Hinders Effective Program Management” (GAO-04-642, May 28, 2004).

## Management's Comments

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



MAR 20 2009

Reply to Attn of:

TO: Assistant Inspector General for Auditing  
FROM: Associate Administrator for the Science Mission Directorate  
SUBJECT: Response to the Draft Memorandum on Audit of the Stratospheric Observatory for Infrared Astronomy (SOFIA) Program Management Effectiveness

The Associate Administrator for the Science Mission Directorate, the Assistant Administrator for Infrastructure, the Director of the Dryden Flight Research Center, and the Director of the Ames Research Center appreciate the opportunity to comment on your "*Draft Memorandum on Audit of the Stratospheric Observatory for Infrared Astronomy (SOFIA) Program Management Effectiveness*," (Assignment No. A-08-011-00) provided to our offices on February 25, 2009. As you requested, we have collaborated on the review of the draft memorandum and in the preparation of this coordinated response.

The Enclosure contains our comments on the draft report, including the recommendations in the draft report. We welcome and encourage further dialog with the Office of the Inspector General to provide further explanation of our response to this draft report.

A handwritten signature in cursive script, appearing to read "Edward J. Weiler".

Edward J. Weiler

Enclosure

**Agency Program Management Response to the Draft Memorandum on Audit of the  
Stratospheric Observatory for Infrared Astronomy (SOFIA) Program Management  
Effectiveness  
March 2009**

Shuttle Carrier Aircraft (SCA)

The Office of Infrastructure (OI) recently received the Dryden Flight Research Center (DFRC) request to transfer the SCA to DFRC for use as spare parts in support of the SOFIA program following retirement of the Space Shuttles in 2010. In compliance with NASA policies on aircraft and personal property, OI will coordinate the transfer request internally as well as with all stakeholders, such as the Shuttle Transition Team, the Space Operations Mission Directorate, the Science Mission Directorate, and the Public Affairs Office.

DFRC's interest in acquiring the SCAs upon the Space Shuttles' final disposition has been informally communicated to the Shuttle Transition Team and the Johnson Space Center. The Space Shuttle Program determines and controls the Last Need Date (LND) and Release Date (RD) for the SCAs. In addition, it has been made known to DFRC's Flight Operations Office that the SCAs would not be physically available until the disposition of the last Space Shuttle, which could be 2012 or later. There may also be interest from external organizations in preserving the SCAs for display purposes. NASA Headquarters coordination on DFRC's aircraft transfer request will address any competing interests in acquiring the SCAs, as well as timing of the physical transfer.

If the transfer of the SCAs to the program is delayed or not approved, the program would purchase one or more additional 747SP airframes for spare parts as a back-up plan.

***Recommendation 1:*** *We recommend that the Assistant Administrator for the Office of Infrastructure and the Director, Dryden Flight Research Center, finalize the agreement to transfer the two Shuttle Carrier Aircraft after the Shuttle Program retirement.*

**Management's Response:** **Concur with the intent of the recommendation to provide for spare parts, and will use the Agency decision process described above to determine disposition of the Shuttle Carrier Aircraft.**

Maintenance and Logistics Plan

The maintenance plan is based on FAA Part 121, modified by NASA to reflect the numerous modifications from the civil version of the aircraft. In accordance with Federal Regulations and long standing NASA policy, NASA is responsible for the airworthiness of the aircraft. Maintenance is currently performed in accordance with this plan. The maintenance plan is currently being updated, with a new version expected to be available by September 2009.

The development of the logistics plan is scheduled to be complete in Q4 of CY2009. This will provide the program with two years to evaluate and implement the logistics plan before the higher flight rates of Limited Operational Capability (LOC) in 2011.

**Recommendation 2:** *We recommend that the SOFIA Program Manager:*

- a. Complete the logistics plan, to include the development of alternative spare parts plans based on various potential retirement dates of the Space Shuttle Program, and maintenance plan in a timely manner.*

**Management's Response:** Concur, noting that this is in work and is scheduled to be complete in Q4 of CY2009.

Earned Value Management

SOFIA is an international program with 20% of development and operations coming from the German Aerospace Center (DLR), such as the telescope and telescope support. Within the NASA portion of the program, the work is led by NASA with three main supporting contractors (i.e., there is no prime contractor). For the three supporting contracts, earned value management is implemented in accordance with NPR 7120.5D (section 3):

- L3: incorporated into contract
- MPC: not required because less than \$20 million
- USRA: not required because this is level of effort for the operation of the science center.

We believe that the principles of earned value management are implemented at the program level relative to program milestones in the form of monthly reports of milestones accomplished vs. plan, and the cost of those milestones vs. plan. This, together with the integrated master schedule of major program and project milestones, provides insight into program performance regardless of who (NASA or DLR) performs specific activities. This approach is consistent with the participating Center's best practices as required in NPR 7120.5D.

**Recommendation 2:** *We recommend that the SOFIA Program Manager:*

- b. Fully implement the Earned Value Management System in compliance with NPR 7120.5D.*

**Management's Response:** Partially concur. We believe that the program is in compliance with 7120.5D. We would welcome further discussion with the OIG to better understand the OIG concerns and discuss the implementation of earned value management to this program.

#### Independent Cost Estimate

Cost estimates were done by the independent SOFIA Options Review Team in April 2006 for several programmatic options. Subsequently, one programmatic option was selected by the Agency, and the program was restructured. As part of the effort leading to rebaselining of the program in July 2007, a cost estimate was performed by this team to support the rebaseline.

***Recommendation 3:*** *We recommend that the Agency Program Management Council request an independent cost estimate to validate the SOFIA Program budget and life-cycle cost estimates.*

**Management's Response:** Concur. This is planned to be performed as part of the Standing Review Board work in early CY2010. This Standing Review Board reports to the Agency Program Management Council. This independent cost estimate will focus on the hybrid nature of the program at this time (part development, part operations) leading to Full Operational Capability.

#### Contractor Cost Control

***Recommendation 4:*** *We recommend that SOFIA Program management coordinate with the SOFIA Program Contracting Officer to:*

- a. Review and modify (if required) all cost plus award fee contracts to ensure Award Fee Determination Plans explicitly reflect cost controls as an evaluation factor with an evaluation weight of no less than 25 percent of the total weighted evaluation factors.*
- b. Ensure that contractor cost control performance is explicitly communicated in future evaluations.*

**Management's Response:** Partially concur. The program will modify the two cost plus award fee contracts to comply with the regulations. As a clarification, the draft report implies that the program overpaid award fee by \$233,600 on the two cost plus award fee contracts cited (L3, MPC). While the cited portion of the fee was not in compliance with the regulations (because this portion was not tied to cost, and instead was tied to business management), the award fee that would have been paid if the full-required tie to cost had been applied would be within 7K of the award fee paid. We ask for clarification from OIG on this matter, as we do not understand how OIG arrived at the determination that a \$233,600 overpayment occurred.

**We would welcome further discussion with the OIG on this matter to better understand and try to resolve this discrepancy.**

Table of Cost History

With respect to the table of cost history in the draft report, two notes are important. First, in the table in the draft report, development budgets for 1997, 2000, and 2003 are not full cost, but for 2008 it is full cost. Second, in the table in the draft report, development budgets before program restructuring in 2006 are for cost to Operational Readiness Review (ORR), but the budget shown for 2008 is 'Full Operational Capability' in 2014. A more appropriate measure to compare with ORR is 'Limited Operational Capability' in 2011 (which would have a budget of \$837 million, not \$1,037 million for FOC shown in the table).

Revised