

NASA's Top Management and Performance Challenges

November 2012

Introduction

Fiscal year (FY) 2012 ended on a high note for NASA with the successful landing of the rover Curiosity on the surface of Mars in August. Over the next several years, Curiosity will explore the Red Planet in an effort to determine if it has ever been able to support life. Earlier in the year, NASA achieved a major milestone toward its goal of fostering the development of a commercial space transportation capability to low Earth orbit with the successful test flight of the Space Exploration Technologies Corporation's (SpaceX) Dragon spacecraft to the International Space Station (ISS), followed in October by the first actual commercial resupply mission.

The year was not without challenges, however. For example, due to cost overruns in the James Webb Space Telescope and other projects, NASA had to reprogram funds away from several Agency initiatives. This resulted in developmental delays in some ongoing projects and cancellation of other planned projects, including the ExoMars/Trace Gas Orbiter missions to Mars.¹

Moreover, the congressional decision to provide NASA's Commercial Crew Program (CCP) with less than half the funding requested by the President in FY 2012 extended to 2017 the earliest date that NASA expects to obtain commercial crew transportation services to the ISS, which is significant if NASA is unable to maintain and utilize the Station beyond its currently scheduled retirement date of 2020. In addition, as a result of the lower-than-expected funding level, the Agency delayed its planned transition from using Space Act Agreements to using Federal Acquisition Regulation (FAR)-based contracts for developing these systems. This decision heightened concern in some quarters about the ultimate ability of the commercial companies to meet NASA safety requirements.

Finally, declining budgets and fiscal uncertainties remained at the forefront of the Agency's decision-making processes this past year. Like the rest of the Federal Government, NASA began FY 2013 under a 6-month continuing resolution (CR) that funds the Agency at FY 2012 levels. Overshadowing the effects of the CR, however, is the possibility of an early January 2013 sequestration that would reduce NASA's anticipated budget by approximately \$1.5 billion. Even if this looming cut is averted, NASA is likely to face constrained budgets for the foreseeable future.

Against this rather bleak budgetary backdrop, we have identified five overarching issues we believe pose the top management and performance challenges to NASA leadership:

- Future of U.S. Human Space Flight
- Project Management

¹ This joint project between the European Space Agency and NASA consisted of missions scheduled for launch in 2016 and 2018.

- Infrastructure and Facilities Management
- Acquisition and Contract Management
- Information Technology Security and Governance

In deciding whether to identify an issue as a top challenge, we considered the significance of the issue in relation to the Agency's mission; its susceptibility to fraud, waste, and abuse; whether the underlying causes are systemic in nature; and the Agency's progress in addressing the challenge. Several of these challenges – specifically project management, infrastructure and facilities management, and acquisition and contract management – are long-standing concerns likely to remain top challenges for the foreseeable future. However, with focused and sustained efforts we believe that NASA can make significant strides in addressing all of the challenges we have identified.

1. Future of U.S. Human Space Flight

NASA's Space Shuttle era, which began with the maiden voyage of Columbia on April 12, 1981, ended after 135 missions when Atlantis landed at Kennedy Space Center on July 21, 2011. In the ensuing year, NASA delivered the four retired orbiters to their permanent homes for public display. NASA's current spaceflight activities are focused on maximizing the productivity of the ISS, encouraging development of commercial companies seeking to provide cargo and crew transportation to the ISS, and developing new systems and technologies for exploration beyond low Earth orbit. Moving each of these programs forward in a "flat" or diminishing budget environment will be a significant challenge for the Agency.

International Space Station. The ISS is currently scheduled to be retired in 2020, although NASA is conducting studies to see if the \$60 billion facility can safely be inhabited and productively utilized until 2028. Whatever its remaining life span, a major focus for the Agency is ensuring the most effective use of the ISS.

One of the most significant factors affecting utilization of the ISS is the amount of time the crew can commit to research. Although NASA has increased average crew research time from 23.9 hours per week in 2010 to 35 hours per week in 2012, the Agency is unlikely to be able to raise that figure given current constraints on crew size.² The ISS was designed to support a seven-member crew. However, because at present the only means of transportation to and from the ISS is the Russian Soyuz, which has a three-person capacity, only six crew members can safely be aboard at one time to allow for evacuation in case of an emergency. This limitation on crew size will exist until at least 2017, the earliest date at which NASA's commercial partners are expected to be ready to fly manned, higher-capacity missions to the ISS.

² NASA, "Consolidated Operations and Utilization Plan (COUP) 2010, Covering the period 2010-2015" (April 26, 2011). Dan Hartman, Manager, Operations Integration, ISS Program Office, "International Space Station Program Status," July 23, 2012, NASA Advisory Committee, Human Exploration and Operations Subcommittee, http://www.nasa.gov/pdf/672214main_1-Hartman_July12_NAC_Final_508.pdf (accessed October 8, 2012).

The other limitation to full utilization is the ability to transport materials and supplies to and from the ISS. SpaceX's Dragon flew a successful demonstration mission to the ISS in May 2012 and began actual resupply missions in October 2012. NASA's other commercial cargo partner, Orbital Sciences Corporation (Orbital), is slated to perform the first demonstration flight of its Antares rocket in December 2012, with a demonstration flight to the ISS with the Cygnus capsule in spring 2013. Although both systems are capable of delivering cargo to the ISS, only Dragon is capable of returning cargo and research experiments to Earth. In fact, other than the very limited capability of Soyuz, Dragon is the only system since the retirement of the Space Shuttles with any "downmass" capability.

In August 2011, NASA entered into a cooperative agreement with the Center for the Advancement of Science in Space (CASIS) initially worth \$15 million per year to manage the non-NASA science activities on the national laboratory portion of the ISS. CASIS, a non-profit organization, is responsible for ensuring that the laboratory is available to the broadest possible cross section of U.S. scientific, technological, and industrial communities. Part of its job is to select the experiments that will be conducted on the national laboratory.

CASIS issued its first public solicitation in June 2012 with the goal of enabling research in the areas of protein crystallization and the life sciences. However, during its first year of operation CASIS encountered a variety of start-up challenges, including the resignation of its executive director, and as of October 2012, did not have a permanent Board of Directors. In the months and years ahead, NASA must ensure that CASIS forms an effective management team; develops a varied research and development portfolio based on national needs for basic and applied research; establishes a marketplace to help match research with funding; and stimulates interest in using the national laboratory for research and technology demonstrations and as a platform for science, technology, engineering, and mathematics education.

NASA also needs to continue encouraging use of the ISS by other U.S. Government agencies, other nations, and the commercial sector while seeking partnerships and cost-sharing arrangements to supplement Agency funding of ISS research and operations. The Office of Inspector General (OIG) expects to issue a report examining NASA's efforts to ensure full utilization of the ISS early next year.

Commercial Launch Providers. Beginning in 2006, NASA entered into a series of Space Act Agreements designed to stimulate development by U.S. industry of transportation systems capable of providing safe and reliable cargo and crew services to the ISS and low Earth orbit. NASA initiated two activities to manage its investments in this area: the Commercial Orbital Transportation Services (COTS) Program and the Commercial Crew Program (CCP). Both programs use Space Act Agreements to support the development of commercial transportation capabilities and FAR-based contracts to certify the capabilities and to procure crew and cargo services to and from the ISS. The availability of domestic crew and cargo capability will enable the United States to transport its own astronauts to the ISS rather than relying on Russian vehicles and provide needed redundancy in cargo and crew transportation systems to the ISS.

NASA has invested \$750 million over the past 7 years in its effort to encourage development of cargo transportation by private companies. Two companies, SpaceX and Orbital, are under contract to resupply the ISS through 2016. As noted above, SpaceX flew its first successful

demonstration flight in May 2012, during which its Dragon spacecraft berthed with the ISS, and its first resupply mission occurred in October 2012. The first demonstration flight of Orbital's Antares rocket and Cygnus space freighter to the ISS is currently scheduled for late spring 2013, with the company's first resupply mission coming as early as 3 months later.

With respect to the development of commercial crew transportation services, in June 2011 we reported on a series of challenges NASA faces in certifying and acquiring those services from commercial entities: (1) modifying the Agency's existing safety and human-rating requirements for commercially developed systems; (2) managing its acquisition strategy for commercial crew transportation services; (3) implementing the appropriate insight/oversight model for commercial partner vehicle development; (4) relying on an emerging industry and uncertain market conditions to achieve cost savings; and (5) managing the relationship between commercial partners, the Federal Aviation Administration, and NASA.³

Although challenges remain, NASA has made progress in addressing several of these issues over the past year. For example, in November 2011 NASA updated and published detailed berthing and docking requirements for cargo and crew delivery systems, and in December 2011 the Agency finalized more than 280 specific safety and human-rating requirements for its CCP. With these requirements in hand, the Agency's commercial partners will have greater insight into what will be required of their systems to attain NASA certification. The documents also provide the Agency's methodology for insight and oversight into whether contractors are meeting the program's requirements. Specifically, NASA embedded teams of NASA employees known as "Partner Integration Teams" with the commercial partners to acquire insight into their development efforts while a separate review board will provide more formal guidance, feedback, and an assessment of the partners' activities.

In August 2012, NASA awarded a third round of Space Act Agreements totaling \$1.11 billion to three companies to further the development of their commercial crew systems.⁴ These Commercial Crew Integrated Capability (CCiCap) awards were made to Boeing Corporation (\$460 million); SpaceX (\$440 million); and Sierra Nevada Corporation (\$212.5 million).⁵ These awards deviated from the acquisition strategy the Agency announced in September 2011, whereby NASA planned to enter into firm-fixed-price contracts with one or more companies that would result in a complete end-to-end design compliant with NASA Crew Transportation System requirements. The award was to be followed by a separate solicitation for competitively awarded contracts to develop, test, evaluate, and certify a company's vehicles. However, when Congress appropriated substantially less than the Agency requested for its CCP in FY 2012 (\$406 million versus \$850 million), NASA changed course and decided to award a third round of Space Act Agreements rather than move to a FAR-based fixed-price contract.

³ NASA OIG, "NASA's Challenges Certifying and Acquiring Commercial Crew Transportation Services" (IG-11-22, June 20, 2011).

⁴ The first two rounds of Agreements consisted of \$50 million in Commercial Crew Development 1 (CCDev 1) awards to five commercial partners and \$300 million in CCDev 2 awards to four partners.

⁵ Nasa.gov, "NASA's Commercial Crew Program Progressing for Future of U.S. Human Spaceflight," *Commercial Space Transportation*, August 8, 2012, <http://www.nasa.gov/exploration/commercial/crew/ccicap-announcement.html> (accessed October 8, 2012).

Both Congress and NASA's Aerospace Safety Advisory Panel (ASAP) have voiced concerns about the Agency's continued reliance on Space Act Agreements in connection with its commercial crew efforts.⁶ At a September 2012 congressional hearing, the ASAP Chairman noted that unlike with traditional FAR-based contracts, when using Space Act Agreements NASA cannot dictate specific requirements to the commercial companies, thereby heightening the risk that the companies will ultimately not be able to deliver vehicles that satisfy NASA safety and performance requirements. NASA, however, believes it can ensure that commercial passenger vehicles will meet its requirements by utilizing a two-phase process. In Phase I, currently scheduled for February 2013, NASA plans to award two to four fixed-price contracts worth up to \$10 million for design acceptance and certification plans for the contractors' crew transportation systems. In Phase II, scheduled for May 2014, NASA plans to award one or two fixed-price contracts for the development, test, evaluation, and certification of the contractors' crew transportation system. This strategy anticipates at least one operational crew transportation system would be certified by NASA for crew transportation missions to the ISS by 2017.

Further complicating NASA's commercial crew effort is the uncertainty surrounding the Federal budget in light of the 6-month CR that essentially holds the Agency to a \$406 million funding level for its CCP. At the September 2012 House hearing, NASA's Associate Administrator for Human Exploration and Operations told Congress that if the CCP is not funded at approximately \$830 million per year for FYs 2014–2017, the Program will face significant schedule delays that will push the first commercial crew launch beyond 2017.

At the same time NASA is fostering the development of commercial cargo and crew capabilities, it has been directed to develop its own launch system and crew vehicle to carry astronauts beyond Earth's orbit. Developing all of these capabilities simultaneously continues to present significant management challenges for NASA leaders.

NASA Launch System and Crew Vehicle. The new heavy-lift rocket under development – the Space Launch System (SLS) – will have an initial capacity of 70 metric tons and eventually be capable of lifting 130 metric tons. As such, the rocket will be capable of more than double the lift capacity of any operational launch vehicle that exists today and America's most powerful since the Saturn V rockets that carried Apollo astronauts to the Moon.

The Multi-Purpose Crew Vehicle (MPCV), which is being developed using an existing contract and is based on design requirements for the canceled Constellation Program's Orion Crew Exploration Vehicle, will be mounted atop the SLS. The MPCV will serve as the crew vehicle for missions beyond low Earth orbit.

The NASA Authorization Act of 2010 set a goal for NASA to achieve operational capability for the SLS and MPCV by December 31, 2016. In November 2011, NASA reported that the Reference Design Vehicles for the SLS and MPCV would be unable to meet all requirements and schedule goals contained in the Authorization Act. Instead, NASA expects to launch an uncrewed test flight of SLS and MPCV in 2017 and the first crewed flight in 2021. NASA also

⁶ September 14, 2012, hearing before the Committee on Science, Space, and Technology Subcommittee on Space and Aeronautics, U.S. House of Representatives.

reported that it plans to conduct a crewed launch once every 2 years thereafter.⁷ In the decades that follow, NASA plans to undertake crewed and robotic missions to destinations beyond low Earth orbit, such as a near-Earth asteroid, the Moon, or Mars. However, no final decisions have been made concerning specific missions and destinations.

NASA's management challenge in this area will be to concurrently develop a launch system and crew vehicle and modify the necessary supporting ground systems while meeting the NASA Administrator's mandate that exploration systems be affordable, sustainable, and realistic. In particular, establishing realistic long-term budgets for the SLS, MPCV, and associated ground support programs will be difficult, as evidenced by an August 2011 independent cost assessment that concluded NASA's estimates are reasonable for near-term budget planning but do not support establishment of long-term budgets or detailed baselines.⁸

Part of the challenge NASA faces in developing long-term budgets is the relative immaturity of the SLS Program. For example, in September 2012 we reported that although the Agency's planned modification to adapt the Ares I Mobile Launcher for use on the SLS was technically feasible and the most cost-effective option for the initial versions of the new rocket, NASA will need to continually assess the modifications as the program evolves and the SLS vehicles become larger and more powerful.⁹ We found NASA's ability to identify the technical risks and accurately estimate future operating costs of modifying the Mobile Launcher throughout the SLS Program life cycle is significantly affected by both the relative immaturity of the SLS Program and the evolvable nature of the SLS vehicles.

NASA's development efforts have also been impacted by the expectation of continued constrained budgets for the foreseeable future. For example, the MPCV Program is anticipating a "flat" budget profile for at least the next 10 years with no increases for inflation. As a result, NASA has adopted an incremental approach in developing the MPCV under which Program officials will concentrate initially on systems needed to meet the specific mission objectives for each test flight rather than working on all MPCV systems concurrently. The OIG is currently examining NASA's efforts to develop the MPCV and will continue to examine NASA's launch and crew transportation development efforts in the years to come.

2. Project Management

Over its 50 year history, NASA has been at the forefront of science and space exploration and responsible for numerous scientific and technological discoveries and innovations. However, in addition to their significant scientific and technological achievements, many NASA projects share another less positive trait – they cost significantly more to complete and take much longer

⁷ NASA, "Final Report Regarding NASA's Space Launch System and Multi-Purpose Crew Vehicle Pursuant to Section 309 of the NASA Authorization Act of 2010 (P.L. 111-267)" (November 2011).

⁸ Booz Allen Hamilton, "Independent Cost Assessment of the Space Launch System, Multi-Purpose Crew Vehicle and 21st Century Ground Systems Programs, Final Report," August 19, 2011, http://www.nasa.gov/pdf/581582main_BAH_Executive_Summary.pdf (accessed November 5, 2012).

⁹ NASA OIG, "NASA's Plans to Modify the Ares I Mobile Launcher in Support of the Space Launch System" (IG-12-022, September 25, 2012).

to launch than originally planned. In this era of constrained Federal budgets, NASA's ability to deliver projects on time and within budget is more important than ever if the Agency is to maintain a robust portfolio of science and space projects.

Over the past year, the OIG conducted an extensive review examining NASA's project management practices in an effort to identify the primary challenges to the Agency achieving its cost, schedule, and performance goals.¹⁰ The core of our fact-finding consisted of interviews of 85 individuals from both inside and outside of the Agency, including the current and former Administrators, Associate Administrators, Center Directors, and project managers and staff.

Key Challenges to Meeting Cost, Schedule, and Performance Goals. Cost increases and schedule delays on its projects are a long-standing issue for NASA. A 2004 Congressional Budget Office study that compared the initial and revised budgets of 72 Agency projects between 1977 and 2000 reported a 61 percent increase between the projects' initial and revised budgets.¹¹ Similarly, the Government Accountability Office (GAO) has consistently reported on cost growth and schedule delays in NASA's major projects. For example, in its 2012 assessment of 21 large-scale projects, GAO reported an average development cost growth of 47 percent or \$315 million, much of which was attributable to the James Webb Space Telescope (JWST). The current "poster child" for NASA's persistent difficulties in controlling cost and schedule growth, JWST has gone from an original life-cycle cost baseline estimate of \$5 billion and a launch date of June 2014 to a projected cost of \$8.8 billion and a launch date of October 2018.¹²

As GAO noted, cost and schedule increases on large projects like JWST can have a cascading effect on NASA's entire portfolio. To illustrate, in FY 2012 NASA moved \$156 million from other Science Mission Directorate projects and the Cross Agency Support account to cover cost increases in the JWST Project.¹³ In addition, several other missions including the Wide-Field Infrared Survey Telescope have been postponed to make funding available for JWST.¹⁴ Moreover, NASA announced in February 2012 that it was pulling out of an agreement with the European Space Agency on two future Mars missions and planned to reevaluate its Mars exploration strategy to accommodate a more restricted funding profile.

In our September 2012 report, we identified four factors that appear to present the greatest challenges to successful project outcomes at NASA:

- **NASA's Culture of Optimism.** Permeating all levels of NASA from senior management to frontline engineers, a culture of optimism is essential to overcoming the

¹⁰ NASA OIG, "NASA's Challenges to Meeting Cost, Schedule, and Performance Goals" (IG-12-021, September 27, 2012).

¹¹ A Congressional Budget Office Study, "A Budgetary Analysis of NASA's New Vision for Space Exploration," September 2004.

¹² GAO, "NASA: Assessments of Selected Large-Scale Projects" (GAO-12-207SP, March 1, 2012).

¹³ NASA's Cross-Agency Support account funds support activities necessary to ensure the operation and administration of the Agency such as human capital management, security, and maintenance of real property assets that cannot be directly aligned to a specific program or project requirement.

¹⁴ The Wide-Field Infrared Survey Telescope is a NASA observatory designed to settle essential questions in both exoplanet and dark energy research.

extraordinary technical challenges inherent in the development of unique, first-of-their-kind space systems. However, this same optimism can sometimes prevent managers and leaders from making critical assessments of requirements, budgets, and schedules to determine what a project can realistically accomplish within a set budget and timetable.

- **Underestimating Technical Complexity.** Project managers we interviewed cited the technical complexity inherent in NASA projects as a major challenge to achieving cost and schedule goals. In our judgment, five factors explain the inherently uncertain nature of estimating costs for the type of space technologies NASA develops: (1) unique, first-of-their-kind technologies; (2) interdependent technologies and complex integration issues; (3) increased testing needs; (4) limited quantities; and (5) shrinking industrial base and reduced quality of parts.
- **Funding Instability.** Funding instability includes situations in which a project receives less money than planned or where funds are disbursed on a schedule different than planned. Such instability may result from presidential, congressional, or Agency-directed actions and can cause work to be delayed and development risks to be identified late in the project life cycle, which in turn can lead to cost increases and schedule delays.
- **Limited Opportunities for Project Managers' Development.** Interviewees stated that the limited number of small and mid-size projects in NASA's current portfolio allows too few opportunities for Agency personnel to gain experience managing a project's cost, schedule, and technical performance efforts. In addition, they expressed concern that an increased reliance on contractors to design and build projects has led to a decline in Agency personnel with development experience. Finally, they stated that NASA engineers are primarily operating as overseers of work performed by contractors rather than gaining experience with in-house builds of instruments and spacecraft.

Given the anticipated funding challenges for all Federal agencies in the years ahead, changes to the way NASA develops and manages its projects are imperative. At the same time, the Agency is undergoing considerable changes in mission focus, with the end of the Space Shuttle Program and the first steps on a new path toward human space exploration. Collectively, these factors both necessitate and provide an opportunity for the Agency to reset itself and take steps toward meaningful change in the way its projects are developed and managed.

Project Management Principles and Tools. To execute projects within established cost and schedule estimates, NASA needs to maximize the use of sound project management principles and tools in projects both large and small. To its credit, NASA has taken several steps in the last few years aimed at curbing cost growth and schedule delays. For example, in response to a 2007 GAO report highlighting NASA's lack of emphasis on cost controls and program outcomes, the Agency issued a Corrective Action Plan that established a definition of success that includes completing all development projects within 110 percent of cost and schedule baselines and meeting Level 1 requirements for 90 percent of the major development projects in its portfolio.¹⁵

¹⁵ "NASA Plan for Improvement in the GAO High-Risk Area of Contract Management," dated October 31, 2007, and updated through January 31, 2008. A Level 1 requirement is a project's fundamental and basic set of requirements levied by the Program or Headquarters.

NASA hopes to achieve the Corrective Action Plan's criteria for success by FY 2013, implementing the policies and processes on new projects while tracking and reporting the measures for existing projects.¹⁶

The Agency also has implemented a cost and schedule analysis methodology that produces what is known as the Joint Cost and Schedule Confidence Level to assist managers with cost and schedule estimating while enabling the Agency to evaluate more accurately whether projects have an executable plan as they proceed into implementation. NASA believes that this analysis has helped projects such as the Gravity Recovery and Interior Laboratory, Juno, and the Mars Atmosphere and Volatile Evolution meet cost and schedule goals.¹⁷

Moreover, NASA's new program and project management policy requires that project plans document decisions to either build or procure items based on NASA's in-house capabilities, maintenance of core competencies, cost, and best overall value to NASA. Project plans must also include baseline and threshold values for the performance metrics to be achieved at each Key Decision Point and mission success criteria associated with the program-level requirements that, if not met, trigger consideration of a Termination Review.¹⁸ Furthermore, project plans are required to document how the project will periodically report cost and schedule performance and provide a mitigation and corrective action plan in the event the project exceeds development cost estimates. More recently, NASA appears to be holding project managers more accountable for meeting cost cap agreements as evidenced by its decision in May 2012 to terminate the Gravity and Extreme Magnetism Small Explorer mission because development costs were likely to exceed the agreed-upon budget.

Apart from those positive actions, NASA was not fully utilizing at least one important tool in its arsenal – its Lessons Learned Information System (LLIS). Since 1994, LLIS has been NASA's principal mechanism for collecting and sharing lessons learned from Agency programs and projects.¹⁹ The information in LLIS is drawn from individuals, directorates, programs, projects, and supporting organizations and personnel across NASA and is one component of NASA's larger knowledge management and sharing system. Sharing lessons learned can reduce risk, improve efficiency, promote validated processes, and improve performance in ongoing and future NASA projects. In a March 2012 OIG report, we documented that NASA's project managers did not routinely use LLIS to search for lessons identified by other projects or routinely contribute new information to LLIS. Specifically, we found inconsistent policy direction and implementation for the Agency's overall lessons learned program; disparate levels

¹⁶ NASA's current set of major development projects were all underway prior to implementation of the Corrective Action Plan. These projects will gradually be completed (NASA's typical timeline for development is 4 years) and replaced with projects that will be fully subject to the Plan.

¹⁷ The Gravity Recovery and Interior Laboratory mission launched on September 10, 2011, to study the Moon's interior. Juno launched on August 5, 2011, to investigate the origin and evolution of Jupiter and is scheduled to arrive at the planet in July 2016. The Mars Atmosphere and Volatile Evolution mission is scheduled to launch in late 2013 to investigate the Martian atmosphere.

¹⁸ NASA Procedural Requirements (NPR) 7120.5E, "NASA Space Flight Program and Project Management Requirements," August 14, 2012.

¹⁹ LLIS is an online, automated database. The public can access LLIS at <http://llis.nasa.gov/llis/search/home.jsp> (accessed October 8, 2012).

of funding for LLIS activities across NASA Centers; deficient monitoring of critical Center-based LLIS activities; and lack of definition in NASA's overall strategy for knowledge management, lessons learned, and LLIS. Consequently, LLIS had been underutilized by project managers and marginalized in favor of other NASA knowledge sharing system components.

3. Infrastructure and Facilities Management

NASA is the ninth largest Federal Government property holder, controlling a network of approximately 4,900 buildings and structures that support Agency research, development, and flight activities. In total, the assets occupy 46 million square feet and their current replacement value is estimated at more than \$30.8 billion. The 2010 Authorization Act requires NASA to develop a strategy for the most efficient retention, sizing, and distribution of facilities and other infrastructure consistent with the Agency's mission. In a time of constrained Federal budgets and transition from the Space Shuttle era, successfully implementing this directive is among the most pressing challenges facing Agency management.

Maintenance, Repair, and Use of Aging Facilities. NASA officials report that more than 80 percent of the Agency's facilities are 40 or more years old and beyond their design life. Under its current policy, NASA is required to maintain these facilities either in an operational status or, if they are not being used, in sufficient condition that they do not pose a safety hazard. However, NASA has not been able to fully fund required maintenance costs for these facilities and in 2011 estimated its deferred maintenance costs at \$2.47 billion.²⁰

NASA has struggled for years with managing its backlog of deferred maintenance projects. The Aerospace Safety Advisory Panel cited the condition of NASA's facilities and infrastructure as an area of concern in its 2011 annual report, and in 2010 the National Research Council cited a "steady and significant decrease in NASA's laboratory capabilities, including equipment, maintenance, and facility upgrades" that require more maintenance than funding permits.

The challenge for NASA leadership in this area is to address the backlog of essential maintenance projects so that facilities will be available when needed to support future missions. Continuing to delay essential maintenance projects poses a threat to the safety of personnel and equipment and likely will result in higher repair costs in the future.

Reducing Unneeded and Duplicative Infrastructure. One way NASA could reduce its facilities maintenance costs is to reduce the amount of underutilized and duplicative infrastructure in its inventory. In the 1990s, GAO issued several reports on NASA's infrastructure challenges and noted that the Agency was building new facilities faster than it was consolidating or closing older ones, resulting in duplication of capabilities. More recently, GAO reported that over 10 percent of NASA's real property assets were either underutilized or not being used at all.²¹ In 2008, NASA's own Program Analysis and Evaluation Office identified

²⁰ NASA, "Deferred Maintenance Assessment Report: FY11 NASA-Wide Standardized Deferred Maintenance Parametric Estimate (Full Assessment)," October 1, 2011.

²¹ GAO, "Federal Real Property: Progress Made Toward Addressing Problems, but Underlying Obstacles Continue to Hamper Reform" (GAO-07-349, April 13, 2007).

203 facilities that had no future mission requirement yet were still listed in the NASA inventory. Finally, an August 2011 OIG audit found numerous NASA facilities that had not been utilized, some for as long as 10 years.²²

The challenge for NASA leadership in this area is to reduce unneeded and duplicative property in light of the key missions, technologies, and programs the Agency intends to pursue over the next 20 to 30 years and the facilities it will need for those pursuits. In this effort, NASA must move beyond its traditionally conservative approach of “keep it in case we need it” in managing its facilities. Fundamental to the success of any such effort will be improving the quality of the Agency’s data regarding its real property assets. To this point, our August 2011 OIG report found that the data in NASA’s primary system for compiling and analyzing its real property assets were unreliable metrics for evaluating utilization, mission dependency, and condition of the Agency’s real property assets largely because NASA Centers used inadequate processes to gather and update this information.

To its credit, NASA has begun to take positive steps toward addressing its infrastructure challenges. For example, in 2011 NASA developed its first integrated, Agency-wide real property master plan, which it intends to use to coordinate resources across the Agency by linking real property needs with projected funding. However, in December 2011 we reported that the Center master plans the Agency was using to develop this integrated plan contained deficiencies that may limit the plan’s usefulness in making strategic real property decisions.²³ Developing an integrated Agency master plan in an uncertain budget environment is a significant challenge for NASA. Nonetheless, as noted in our report, better Center master plans will help NASA develop a more comprehensive Agency master plan, which in turn will enable the Agency to make better strategic decisions regarding its real property assets.

In addition to its Agency-wide master planning effort, NASA is taking further action to better identify and assess the Agency’s strategic capabilities and the real property assets that will be needed to support those capabilities.²⁴ For example, the Agency has strengthened central authority over infrastructure decisions and initiated efforts to improve data management and better assess technical capability needs across the Agency. To assist in the Agency’s efforts to reduce its real property, the OIG is conducting an audit examining NASA’s efforts to identify and reduce unneeded and duplicative test stands, wind tunnels, vacuum chambers, airfields, and Space Shuttle-related infrastructure.

Leased Space at NASA Centers. Leasing offers the Agency another means to help address the maintenance costs of its aging and underutilized facilities. However, Federal law and policy prohibits NASA (and other Government agencies) from leasing facilities for which it has no current or future mission-related use. For these facilities, NASA should consider other options, such as demolition or transferring the property to the General Services Administration for sale or

²² NASA OIG, “NASA Infrastructure and Facilities: Assessment of Data Used to Manage Real Property Assets” (IG-11-024, August 4, 2011).

²³ NASA OIG, “NASA’s Infrastructure and Facilities: An Assessment of the Agency’s Real Property Master Planning” (IG-12-008, December 19, 2011).

²⁴ NASA defines a capability as the necessary infrastructure, equipment, workforce and other direct costs required to accomplish a given mission requirement.

transfer to another entity. The challenge for NASA is to use leasing when appropriate to generate revenue to offset facilities operations and maintenance costs while not using it as a way to hold on to facilities the Agency does not need. Leasing property under the latter scenario frustrates the Agency's efforts to reduce its real property footprint and can divert effort and resources from its core missions.

An August 2012 OIG review found that NASA lacks clear guidance to ensure that property identified for leasing was not excess to the Agency's needs.²⁵ We also determined that NASA lacked a complete inventory of space available for lease as well as an effective marketing program to attract potential tenants. In addition, we found internal control weaknesses that limit NASA's ability to ensure that leases provide the best value to the Agency and are fair to its partners and potential partners. Absent better controls and improved guidance, NASA will be hard-pressed to maximize the potential of its leasing program to help reduce the cost of maintaining underutilized facilities while meeting its obligation to ensure that leasing does not become a substitute for disposing of excess property.

One tool available to NASA is Enhanced-Use Leasing (EUL), which allows the Agency to retain the proceeds it derives from leasing underutilized real property rather than turning them over to the U.S. Treasury. In FY 2003, Congress granted EUL authority to Ames Research Center and Kennedy Space Center. Using this authority, Kennedy entered into an EUL with a Florida utility for a 60-acre site that supports a solar farm that generates 1 percent of the Center's power needs. Under subsequent legislation, all Centers may enter into EULs in which they receive either cash payments or in-kind consideration related to the development of renewable energy production facilities.

4. Acquisition and Contract Management

Approximately 81 percent of NASA's \$18.5 billion FY 2011 budget was spent on contracts to procure goods and services and provide funding to grant and award recipients. As the President and Congress work to reduce Federal spending and the country's budget deficit, NASA is likely to face constrained funding levels for the foreseeable future. Accordingly, it is critical that NASA work to ensure that the billions of dollars of taxpayer funds entrusted to it are spent wisely. However, systemic weaknesses in NASA's internal controls related to acquisition and contracting continue to create challenges for the Agency. The OIG will continue to focus resources on this issue to identify fraud, waste, and abuse by contractors and awardees as well as weaknesses in the Agency's system of internal controls.

²⁵ NASA OIG, "NASA's Infrastructure and Facilities: An Assessment of the Agency's Real Property Leasing Practices" (IG-12-020, August 9, 2012).

Contract Management. Given the large amount of taxpayer funds NASA spends on contract awards, managers are constantly challenged to ensure that the Agency pays contractors in accordance with contract terms and receives fair value for its money. During the past year, the OIG continued to uncover fraud and overcharging by NASA contractors. Specifically, as a result of our investigative work in the past year:

- A Government contractor and its parent company agreed to pay \$3.3 million to settle allegations that they included unallowable costs in calculating overhead rates for NASA and national defense-related contracts.
- Another Government contractor agreed to pay \$617,789 to settle allegations that it submitted inflated invoices for engineering and technical services it provided to Dryden Flight Research Center.
- A Texas business owner pleaded guilty and was sentenced to 3 years' probation for making a false statement concerning space vehicle parts his business supplied to NASA for use on the ISS. The investigation found that the business owner had certified that ratchets his company produced met contract specifications when he knew they did not.

The OIG's audit work during the past year also identified weaknesses in NASA contract management. For example, we examined whether research funded by NASA Research Announcements (NRAs) advanced the Agency's aeronautics research goals and whether award costs were allowable and properly supported.²⁶ Although we found that these NRA awards advanced the Agency's aeronautics research goals, we also found that 18 of the 43 awards we reviewed (42 percent) contained approximately \$2.4 million in questioned costs: \$22,114 in unallowable fees, and \$2,405,635 in unsupported costs.²⁷ Based on our sample results, we estimated that the NRA awards made by the Aeronautics Research Mission Directorate from May 2006 through January 2011 contained \$25.2 million in unallowable or unsupported costs.

In another audit, we reviewed NASA's compliance with the Duncan Hunter National Defense Authorization Act of 2009 and found contract files lacking documentation related to acquisition plans and rationales supporting the type of contracts selected.²⁸ We also identified several instances where the contracting officer's technical representative was not timely assigned and cases where NASA had not validated the adequacy of the contractor's accounting system – both critical to management and oversight of contractor performance. Recently, we initiated an audit

²⁶ NRAs are solicitations that announce research opportunities and provide a formal mechanism for corporations, universities, and research institutions to submit project ideas. From 2006 to 2010, NASA spent approximately \$1.3 billion on NRA awards, of which approximately \$435 million was spent by the Aeronautics Research Mission Directorate.

²⁷ NASA OIG, "NASA's Use of Research Announcement Awards for Aeronautics Research" (IG-12-011, April 30, 2012)

²⁸ The Act requires OIGs to report on their agencies use of cost-reimbursement contracts and level of compliance with applicable FAR rules related to the appropriate documentation for the award, use, and management of those contracts. See NASA OIG, "Final Memorandum on NASA's Compliance with Provisions of the Duncan Hunter National Defense Authorization Act of 2009 – Management of Cost-Reimbursement Contracts" (IG-12-014, March 14, 2012).

of NASA's Strategic Sourcing Program to determine whether the Program has been effectively implemented and whether it has resulted in cost savings for NASA.

One area in which NASA continues to be particularly challenged with regard to safeguarding against fraud is its Small Business Innovation Research (SBIR) program. NASA awarded approximately \$190 million to small businesses under this program during FY 2011 to stimulate technological innovation, increase participation by small businesses in federally funded research and development, and increase private sector commercialization of innovations derived from federally funded research and development efforts. In multiple investigations and audits over the years, the OIG has identified significant fraud, waste, and abuse in NASA's SBIR program. For example, this past year an OIG investigation resulted in the suspension of a technology firm and two of its principals from participation in Federal procurements for failing to disclose that the principals were primarily employed by a university when they submitted proposals to participate in the NASA and Navy SBIR programs.

Moving forward, the OIG will continue to closely monitor the Agency's SBIR activities and work collaboratively with the Agency to improve performance in this area.

Grant Management. NASA faces the ongoing challenge of ensuring that the approximately \$500 million in grants it awards annually are administered appropriately and that recipients are accomplishing stated goals. The Agency makes these awards to facilitate research and development projects; to fund scholarships, fellowships, or stipends to students and teachers; and to fund educational research performed by educational institutions or other non-profit organizations.

Over the past 5 years, the OIG conducted 40 grant fraud investigations resulting in three prosecutions and \$12.5 million in restitution and recoveries. As a result of one recent investigation, the Department of Justice filed a civil complaint under the False Claims Act alleging that a NASA grant recipient improperly spent over \$3.75 million in grant funds intended for research purposes on construction of a building.

In September 2011, the OIG reported that NASA did not have an adequate system of controls in place to ensure proper administration and management of its grant program and that as a result some grant funds were not being used for their intended purposes.²⁹ Following this report, we conducted three audits examining whether specific NASA grants are being used for their intended purpose and whether associated costs are allowable, reasonable, and in accordance with applicable laws, regulations, guidelines, and terms of the grants.³⁰ Although we did not find any evidence of fraud or abuse in these audits, we did identify a number of internal control deficiencies and improvements needed in NASA's grant oversight and management. For example, we determined that the Philadelphia College Opportunity Resources for Education, a not-for-profit organization that provides college scholarships to high school seniors, had charged

²⁹ NASA OIG, "NASA's Grant Administration and Management" (IG-11-026, September 12, 2011).

³⁰ NASA OIG, "Audit of NASA Grants Awarded to the Alabama Space Science Exhibit Commission's U.S. Space and Rocket Center" (IG-12-016, June 22, 2012); NASA OIG, "Audit of NASA Grants Awarded to the Philadelphia College Opportunity Resources for Education" (IG-12-018, July 26, 2012); and NASA OIG, "Audit of NASA Grant Awarded to HudsonAlpha Institute for Biotechnology" (IG-12-019, August 3, 2012).

\$60,511 in unallocable or unallowable expenditures and failed to maintain appropriate time and attendance documentation to support personnel charges totaling \$156,409.

NASA is faced with the challenge of conducting active oversight of grant recipients within resource and staffing limitations. Consequently, we will continue to focus resources in this area as the Agency works to enhance its grant management processes.

5. Information Technology Security and Governance

NASA's portfolio of information technology (IT) assets includes more than 550 information systems that control spacecraft, collect and process scientific data, and enable NASA personnel to collaborate with colleagues around the world. Hundreds of thousands of NASA personnel, contractors, academics, and members of the public use these IT systems daily and NASA depends on them to carry out its essential operations. Overall, NASA spends more than \$1.5 billion annually on its IT-related activities, \$58 million of that for IT security. Although many NASA IT systems contain data that may be widely shared, some systems house sensitive information which, if lost or stolen, could result in significant financial loss, adversely affect national security, or significantly impair our Nation's competitive technological advantage.

Over the past 5 years, we have issued 21 audit reports containing 69 IT-related recommendations. In addition, OIG investigators have conducted more than 16 separate investigations of breaches of NASA networks, several of which have resulted in the arrests or convictions of foreign nationals in China, Great Britain, Italy, Nigeria, Portugal, Romania, Turkey, and Estonia.

IT Security Weaknesses. Through our audits and investigations, we have identified systemic and recurring weaknesses in NASA's IT security program that adversely affect the Agency's ability to protect the information and information systems vital to its mission. For example, NASA has been slow to implement full-disk encryption on notebook computers and other mobile computing devices it provides to its employees, potentially exposing sensitive information to unauthorized disclosure when such devices are lost or stolen. Between April 2009 and April 2011, NASA reported the loss or theft of 48 Agency mobile computing devices, which resulted in the unauthorized release of sensitive information including Social Security numbers, export-controlled data on NASA's Constellation and Orion programs, and third-party intellectual property. Although NASA has selected an enterprise solution for encrypting data on its mobile computing devices and hopes to complete implementation by March 31, 2013, until this process is complete, sensitive data on the Agency's mobile computing and portable data storage devices will remain at high risk for loss or theft.

We also found that NASA continues to experience challenges as it moves from a compliance-focused "snapshot" approach for measuring the security of its IT systems to using tools and techniques to perform real-time security control monitoring. Although NASA has made progress implementing such a continuous monitoring program, the Agency needs to: (1) create and maintain a complete, up-to-date record of IT components connected to Agency networks; (2) define the security configuration baselines that are required for its system components and develop an effective means of assessing compliance with those baselines; and (3) use best

practices for vulnerability management on all its IT systems. Only by making improvements in each of these areas can NASA ensure that its continuous monitoring program will adequately protect Agency IT assets.

The CIO's inability to ensure that NASA's mission computer networks implement key IT security controls continues to put these critical IT assets at risk of compromise. Through our work we have found that Agency mission networks do not consistently implement key IT security controls. For example, the Agency has not yet implemented two recommendations from a May 2010 OIG audit report to monitor its mission networks for the presence of critical software patches and technical vulnerabilities.³¹ Moreover, our detailed control tests of mission networks in 2010 and 2011 identified several high-risk technical vulnerabilities on systems that provide mission support to spacecraft. Until NASA implements measures to better protect its mission networks, they will remain at risk of compromise, which could have a severe adverse effect on NASA operations, assets, or personnel.

Attacks on IT Infrastructure. In 2010 and 2011, NASA reported 5,408 computer security incidents resulting in the installation of malicious software on or unauthorized access to its computers. Such incidents disrupt Agency operations and can result in the loss or theft of sensitive data from NASA systems. NASA remains a target both because of the large size of its networks and because its information is highly sought after by criminals attempting to steal technical data or further other criminal activities. Moreover, NASA has increasingly become a target of a sophisticated form of cyber attack known as advanced persistent threats (APTs). The individuals or nations behind these APTs are typically well organized and well funded and often target high-profile organizations like NASA. Our investigation of a recent APT attack at the Jet Propulsion Laboratory (JPL) involving Chinese-based Internet protocol addresses has confirmed that the intruders gained full system access to numerous JPL systems and sensitive user accounts. With full system access the intruders could: (1) modify, copy, or delete sensitive files; (2) add, modify, or delete user accounts for mission-critical JPL systems; (3) upload hacking tools to steal user credentials and compromise other NASA systems; and (4) modify system logs to conceal their actions.

In an effort to improve the Agency's capability to detect and respond to these evolving threats, in November 2008 NASA consolidated its Center-based computer security incident detection and response programs into a single, Agency-wide computer security incident handling capability called the Security Operations Center (SOC). In an August 2012 audit, we found that establishment of the SOC had improved NASA's computer security incident handling capability by providing continuous incident detection coverage for all NASA Centers.³² Moreover, the SOC's communication processes, including weekly conference calls and security bulletins, were effective for sharing security incident and threat information with responders across the Agency. Finally, we found that NASA implemented an effective information system that enables Agency-wide management and reporting of IT security incidents.

³¹ NASA OIG, "Review of the Information Technology Security of [a NASA Computer Network]" (IG-10-013, May 13, 2010).

³² NASA OIG, "Review of NASA's Computer Security Incident Detection and Handling Capability" (IG-12-017, August 7, 2012).

However, we also found that NASA's computer systems and networks remain at high risk for loss of sensitive data because the Agency's network firewalls and the SOC's intrusion detection capability are ineffective for either detecting or preventing APTs from bypassing the Agency's firewalls and perimeter defenses. Moreover, even after NASA fixes the vulnerability that permitted the attack to succeed, the attacker may covertly maintain a foothold inside NASA's system for future exploits. The increasing frequency of APTs heightens the risk that key Agency networks may be breached and sensitive data stolen. We made three recommendations in our report for enhancing the Agency's capability to detect and prevent these types of sophisticated cyber attacks and to improve overall SOC availability. The Agency is in the process of implementing these recommendations.

NASA IT Governance. Achieving the Agency's IT security goals will require sustained improvements in NASA's overarching IT management practices and governance. Effective IT governance is the key to accommodating the myriad interests of internal and external stakeholders and making decisions that balance compliance, cost, risks, and mission success. Effective IT governance also helps ensure that public funds are efficiently spent by coordinating spending across NASA when purchasing IT products and services.

Federal law and NASA policy designate the Agency Chief Information Officer (CIO) as the official responsible for developing IT security policies and procedures and implementing an Agency-wide IT security program. However, we have found that the CIO has limited ability to direct NASA's Mission Directorates to fully implement CIO-recommended or mandated IT security programs.

NASA's IT assets generally fall into two categories: (1) the "institutional" systems and networks the Agency uses to support such administrative functions as budgeting and human resources and (2) the "mission" systems and networks that support the Agency's aeronautics, science, and space programs such as the Mission Operations Directorate at Johnson Space Center, the Huntsville Operations Center at Marshall Space Flight Center, and the Deep Space Network at JPL. While the CIO has a complete inventory of and the authority to implement the Agency's IT security program for NASA's institutional IT assets, the CIO cannot fully account for or ensure that NASA's mission IT assets comply with applicable IT security policies and procedures.

IT assets on NASA's mission computer networks are funded by the related Mission Directorate, which is responsible for IT security, including the authority for risk determination and risk acceptance. Moreover, IT staff responsible for implementing security controls on mission IT assets report to officials in the Mission Directorate, not the NASA CIO. Thus, the CIO does not have the authority to ensure that NASA's IT security policies are consistently followed across the Agency.

We are currently conducting a review examining NASA's IT governance structure and anticipate making recommendations for improvement.