National Aeronautics and Space Administration

NASA's FY 2015 Management and Performance

Governance and Strategic Management

Management Priorities and Challenges

FY 2014 Performance Plan Update
FY 2015 Performance Plan
FY 2013 Annual Performance Report

http://www.nasa.gov

NASA'S APPROACH TO PERFORMANCE MANAGEMENT

NASA's FY 2015 Management and Performance section[1,2] is an appendix to NASA's 2015 Congressional Justification. This section summarizes NASA as an organization and NASA's approach to performance management, strategic planning, and performance reporting. The overview of NASA explains how the Agency is organized, governed, and managed; and how the Agency uses data, evaluations, and reporting to manage performance. Two additional sections describe NASA's management priorities and challenges and NASA's reported performance for FY 2013 and performance measures for FY 2014 and FY 2015.

A Performance-Based Organization

NASA is a performance-based organization, as defined and described by the Office of Management and Budget's (OMB's) Circular A-11. A performance-based organization commits to management towards specific measurable goals derived from a defined mission, using performance data to continually improve operations. The concept of a performance-based organization was initiated and codified in the Government Performance and Results Act (GPRA) of 1993, and was updated in the GPRA Modernization Act of 2010. As a performance-based organization, NASA is dedicated to results-driven management focused on optimizing value to the American public. It sets concrete goals and holds itself accountable to those goals through a transparent framework of how to measure progress.

NASA VISION AND MISSION

NASA's Vision and Mission are defined collaboratively through internal and external stakeholder input. NASA last revised these Vision and Mission statements in the 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html).

NASA's Vision is:

> We reach for new heights and reveal the unknown for the benefit of humankind.

NASA's Mission is to:

> Drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of Earth.

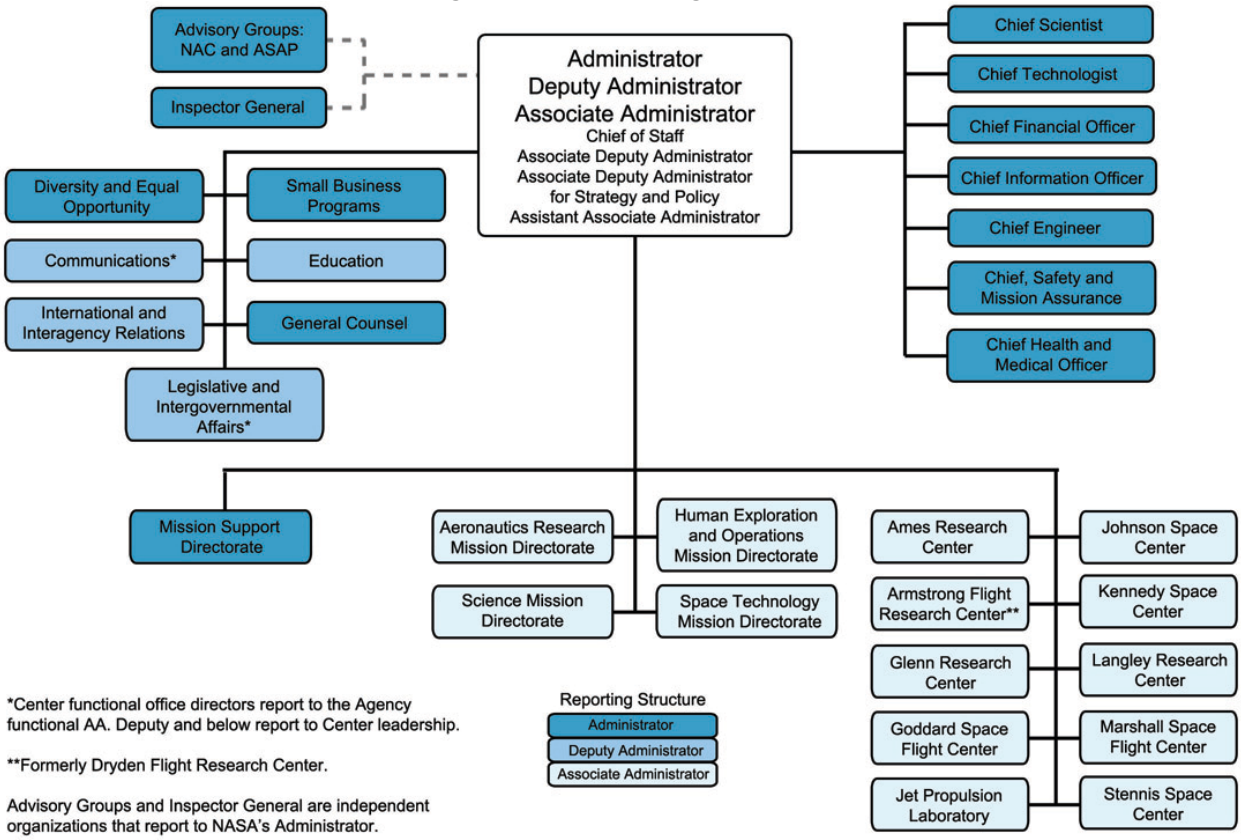
ORGANIZATIONAL STRUCTURE

NASA's organizational structure is designed to accomplish its Mission through sound business, management, and safety oversight. Under the leadership of the Administrator, NASA offices at Headquarters in Washington, DC, guide and direct the Agency. The Office of the Administrator provides top-level strategy and direction for the Agency. The Administrator and his staff give programmatic

[1] Printed versions of NASA's 2015 Congressional Justification only will include a section of NASA's FY 2015 Management and Performance appendix titled "NASA's Approach to Performance Management." For the full version of the Management and Performance section, see: http://www.nasa.gov/news/budget/index.html.
[2] The Management and Performance appendix is produced by NASA's Office of the Chief Financial Officer with contractor support by The Tauri Group.

direction for NASA's missions and guide the operations of the Centers. NASA's Centers and installations conduct the Agency's day-to-day work. Figure 1 depicts NASA's organizational structure, current as of March 2014.

Figure 1: NASA's Organization



NASA Policy Directive 1000.3D, "The NASA Organization," establishes the roles and responsibilities of NASA senior management. The following components have unique portfolios, budget oversight, and performance management responsibilities in executing the Mission.

- Science Mission Directorate (SMD) manages the Agency's Science portfolio budget account and focuses on programmatic work on Earth, planetary, astrophysics, and heliophysics research. SMD engages the U.S. science community, sponsors scientific research, and develops and deploys satellites and probes in collaboration with NASA's international partners to answer fundamental scientific questions and expand the understanding of space. Additional information on SMD is available at http://science.nasa.gov/.
- Aeronautics Research Mission Directorate (ARMD) manages the Agency's aeronautics research account and portfolio of activities that enable game-changing technology innovation and development, allowing the U.S. aviation industry to continue to grow and maintain global competitiveness. Research programs conduct cutting-edge research at both the fundamental and integrated systems levels to address national and global challenges. ARMD guides its research efforts using a strategic vision that embraces the multiple roles of aviation and expands the

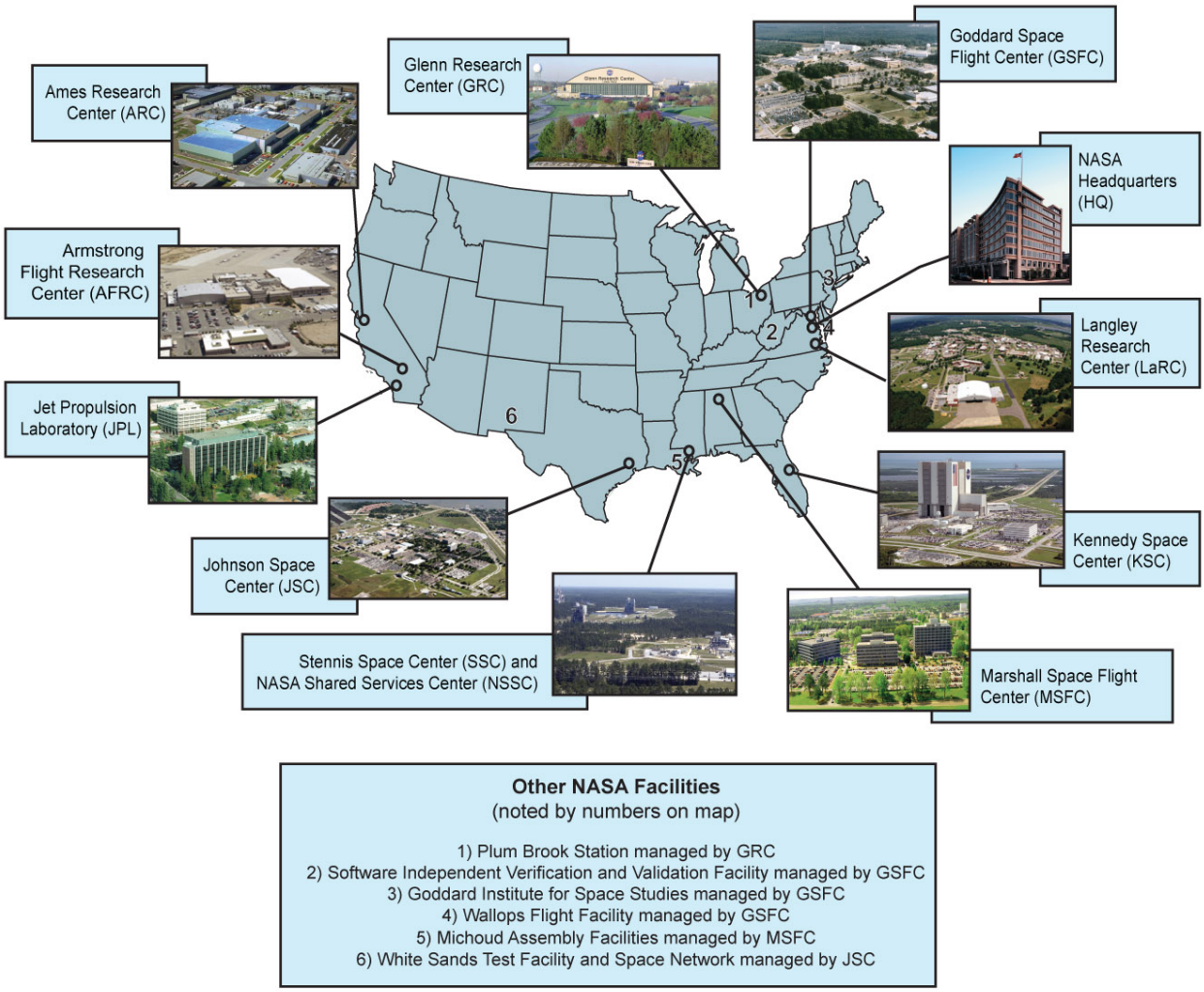
understanding of those roles to the global stage, while working to address tomorrow's challenges. Additional information on ARMD is available at http://www.aeronautics.nasa.gov/.

- Space Technology Mission Directorate (STMD) manages the Space Technology account, which also funds the crosscutting activities of the Office of the Chief Technologist. STMD pioneers new technologies and capabilities needed by the Agency and commercial sector. It complements technology development in NASA's other mission directorates, delivering solutions to NASA's technology needs for future science and exploration missions. Additional information on STMD is available at http://www.nasa.gov/directorates/spacetech/home/index.html. Additional information on the Office of the Chief Technologist is available at http://www.nasa.gov/offices/oct/home/index.html.
- Human Exploration and Operations Mission Directorate (HEOMD) manages the budget account for the Exploration and Space Operations portfolio. HEOMD manages development of the Space Launch System (SLS), Orion, future exploration technologies, and works with U.S. commercial space industry partners to develop commercial systems for providing crew and cargo transportation services to and from low Earth orbit. HEOMD also manages operations and research for the International Space Station (ISS), and communications systems and networks that enable deep space and near-Earth exploration. Additional information on HEOMD is available at http://www.nasa.gov/directorates/heo/home/index.html.
- Mission Support Directorate (MSD) supports all NASA missions in a crosscutting manner. For example, MSD manages the Cross Agency Support (CAS) and Construction and Environmental Compliance and Restoration (CECR) accounts, which cut across all mission directorates. CAS and CECR accounts fund operations at Headquarters and the Centers, as well as institutional and programmatic construction of facilities. MSD reports progress on major national initiatives to the Administrator and other senior Agency officials, provides independent reviews and investigations, and liaises with the public and other Federal agencies. MSD is based at Headquarters, but has representatives at the Centers to provide coordination and control. Additional information on MSD is available at http://msd.hq.nasa.gov/.
- Office of Education (Education) develops and manages a portfolio of educational programs for students and teachers at all levels. Education seeks to develop a vibrant pool of individuals for the future workforce for sustainable support of national and NASA missions by attracting and retaining students in science, technology, engineer, and mathematics disciplines, and raising public awareness of NASA's activities. To achieve these goals, Education works in partnership with other Government agencies, nonprofit organizations, museums, and the education community at large. Additional information on the Office of Education is available at http://www.nasa.gov/offices/education/about/.
- The Administrator's Staff Offices support the Administrator's responsibilities by providing a range of high-level guidance and support in critical areas like safety and mission assurance, technology planning, equal opportunity, information technology, financial administration, small business administration, international relations, and legislative and intergovernmental affairs. Additional information on the Administrator's Staff Offices is available at http://www.nasa.gov/about/org_index.html.
- The Office of Inspector General conducts audits, reviews, and investigations of NASA programs to prevent and detect fraud, waste, abuse, and mismanagement and to assist NASA management in promoting economy, efficiency, and effectiveness. Additional information on the Office of Inspector General is available at http://oig.nasa.gov/.

A dedicated workforce transforms NASA's Mission into reality. NASA employs about 18,000 civil servants at Headquarters in Washington, DC, its Centers, and other facilities across the country. NASA

staffs each location with a contractor workforce for technical and business operations support. Figure 2 shows the distribution of NASA's Centers and major facilities. NASA also has many other facilities throughout the country and around the world.

Figure 2: NASA Centers and Facilities Nationwide



Governance and Strategic Management

GOVERNANCE

Agency governance is critical to mission success and delivering on the Agency's commitment to good stewardship of taxpayer resources. Governance is the way decisions are made and the foundation on which NASA is managed. Good governance is indispensable for NASA's success, and it requires consistent management, cohesive policies, guidance, and process. NASA governs through a combination

of councils and key executive roles, whose decisions are implemented by a unique organizational structure and decision authorities.

NASA governs through three Agency-level councils, each with distinct charters and responsibilities. Councils evaluate issues and support decision authorities when topics require high levels of integration, visibility, and approval. Councils are used to provide high-level oversight, set requirements and strategic priorities, and guide key assessments of the Agency. The three councils are the Executive Council (EC), the Program Management Council (PMC), and the Mission Support Council (MSC). The EC focuses on major Agency-wide decisions; the MSC focuses on mission-enabling decisions; and the PMC focuses on program and mission decisions as programs reach Key Decision Points (KDPs). Regardless of organizational position, senior managers are accountable to the respective council chairs.

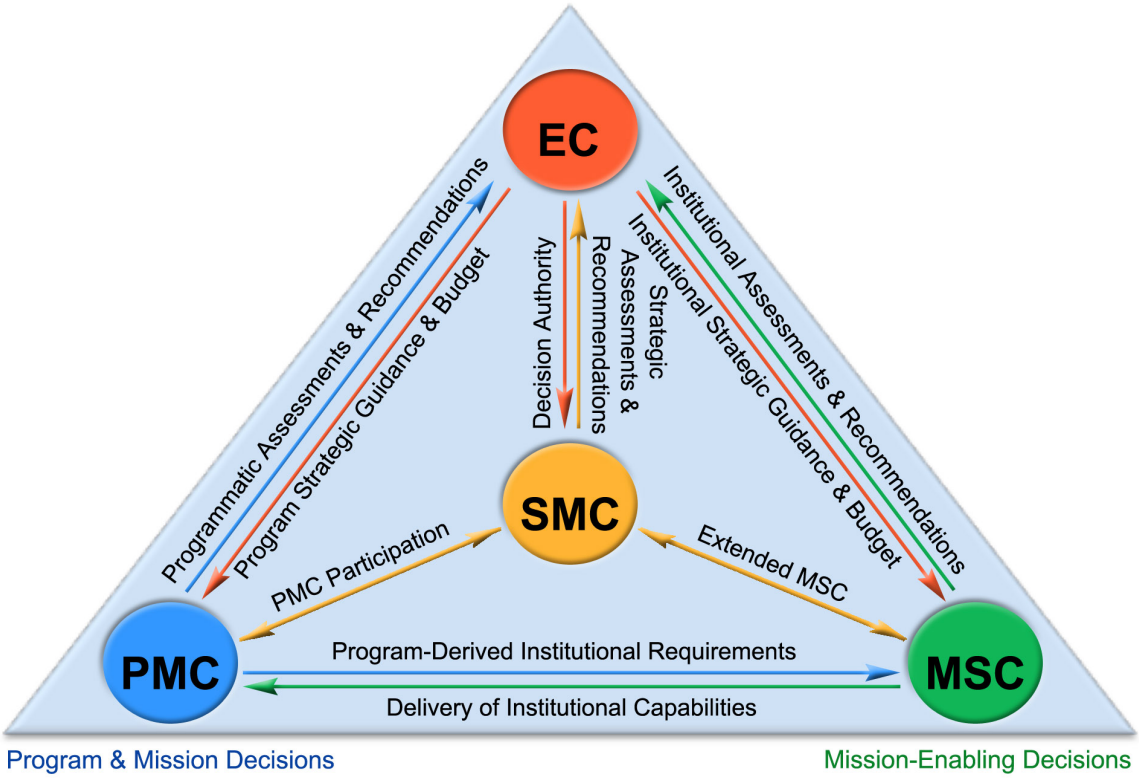
NASA's governance policy ensures that leadership approaches strategic management decisions with rigor and reliable data. As shown in Figure 3, the governance councils affect all phases of the performance management cycle.

While governing through councils, NASA's Mission-driven organization relies on the line organization for implementation. Stemming from the mission directorates and Centers, implementation takes place primarily at the program or project level, where requirements, budget, and schedule are managed. Managers make and implement decisions within their area of responsibility and within the context of the larger organization. Accordingly, they have authority over their approved budgets, schedules, workforce, and capital assets. However, managers also work across organizational lines to achieve program and project integration and to ensure appropriate synergy and effective resource utilization.

Each month, NASA conducts an internal assessment, the Baseline Performance Review (BPR), that tracks performance against Agency decisions. The BPR, led by the Associate Administrator, is a bottom-up review of how well the Agency has performed against its strategic goals and other performance metrics, such as cost, schedule, contract, and technical commitments. Additional advice and assessment is solicited from external bodies within the science and research communities.

At the request of the Office of the Administrator, elements in the formal organization or special ad hoc teams address integration issues that cross-organizational responsibilities of mission directorates, mission support offices, and Centers.

Figure 3: Functional Relationships Between NASA's Governing Councils



In addition to the governing councils, the Strategic Management Council (SMC) is a larger body of internal subject matter experts that provides advice and counsel to senior leadership on key issues of the Agency; provides input on the formulation of Agency strategy; and when delegated by the EC, serves as the Agency senior decision-making body on specific topics of strategic direction and planning.

The Administrator leads the Agency and is accountable to the President for all aspects of the Agency's Mission, including establishing and articulating the Agency's Vision, strategy, and priorities and overseeing successful implementation of supporting policies, programs, and performance assessments. The Administrator performs all necessary functions to govern NASA operations and exercises the powers vested in NASA by law.

The GPRA Modernization Act requires all agency heads to designate an Agency Chief Operating Officer (COO) and Performance Improvement Officer (PIO) for managing Agency performance. The Administrator appoints the COO and the PIO to ensure the Agency's mission is achieved through management of activities in accordance with the GPRA Modernization Act. NASA's Associate Administrator is the current COO and the Director of the Strategic Investments Division in the Office of the Chief Financial Officer is the current PIO. NASA's PIO reports to the COO.

The three primary responsibilities of NASA's performance leaders are goal setting, assuring timely, actionable performance information is available to decision-makers at all levels of the organization, and conducting frequent data-driven reviews that guide decisions and actions to improve performance

outcomes and reduce costs. NASA's COO provides organizational leadership to improve performance; helps the Agency meet the Mission and goals of the Agency through performance planning, measurement, analysis, and regular assessment of programs; chairs data-driven performance reviews; and redirects resources to priorities, including budget and staffing, to improve performance. The PIO supports the Administrator and COO by leading efforts to set goals; conducting quarterly, data-driven performance reviews and analysis; coordinating cross-agency collaboration and Agency leadership on performance; ensuring alignment of personnel performance; communicating performance goals; and collaborating with mission directorates, mission support offices, leadership, and OMB to set meaningful goals.

STRATEGIC MANAGEMENT

NASA's performance management activities follow a continuous cycle to ensure strategic management and accountability. Figure 4 depicts how the three phases of NASA's performance management cycle relate.

Figure 4: Performance Management Cycle

The planning phase is a continuous, iterative process of assessment and adjustment of NASA's Mission objectives at both the strategic and detailed levels to reflect national priorities, Congressional guidance, and other stakeholder input. Forming the foundation of the Strategic Management System are the processes for strategic long- and near-term planning. These processes take into account differing time

spans and the complex interactions of guidance and requirements, independent assessments and analyses, and specific needs of a multi-faceted organization. Strategic long-term planning analyses and initiatives are focused on the timeframes of 10 years or beyond and provide context and input to the NASA Strategic Plan and near-term planning efforts.

In the evaluation phase, NASA holds leadership accountable for near-term performance standards and metrics and progress towards long-term objectives. Program authorities hold internal reviews on a regular basis to monitor and evaluate performance. The results support internal management processes and decision-making. The COO reviews progress towards the Agency program and project plans and addresses crosscutting concerns that may affect performance. Additionally, NASA's COO and PIO review progress towards strategic objectives annually.

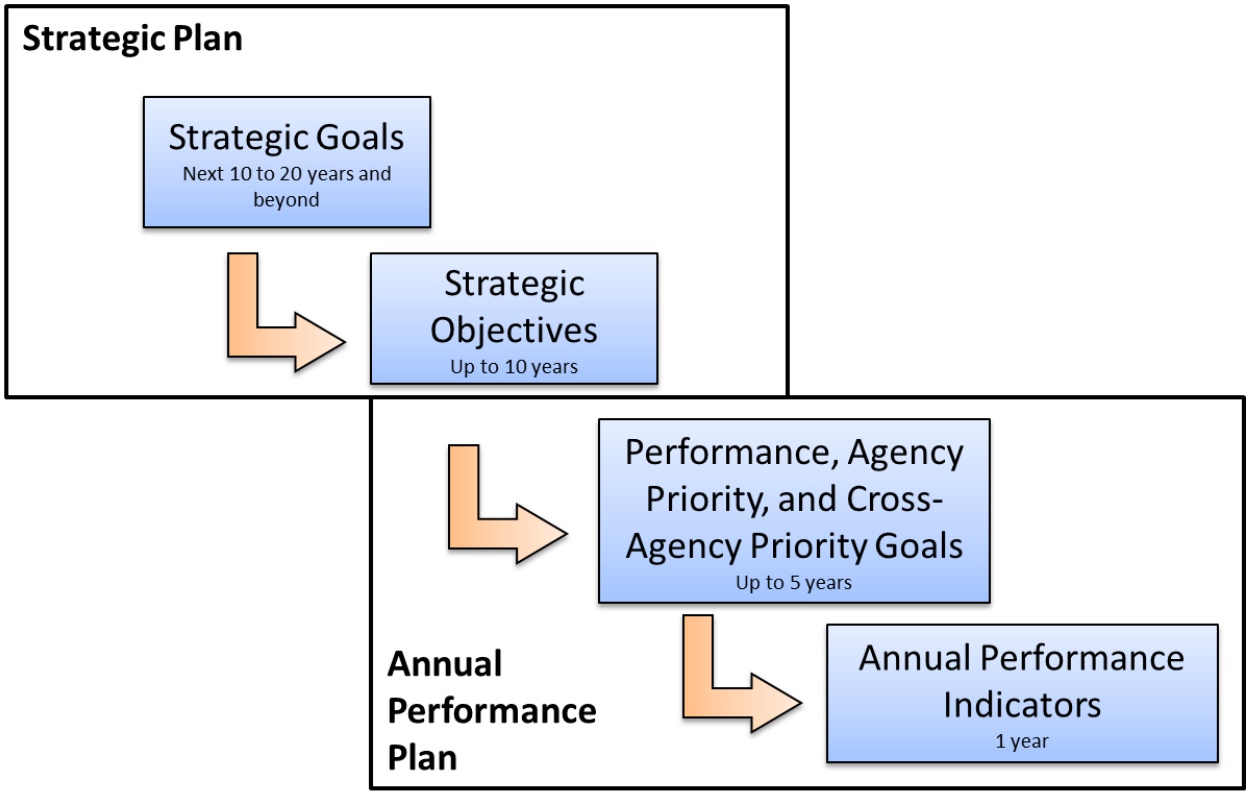
The reporting phase connects evaluation to planning efforts. NASA managers present performance information to senior leaders, such as council members, and other stakeholders. Performance results inform investment, policy, and performance decisions made in the planning phase of the next performance management cycle.

The Strategic Plan, as set by the EC, establishes a strategy and performance framework that aligns short-term performance targets with the Agency's long-term commitments. The current strategy and performance framework consists of the elements of the Strategic Plan and Annual Performance Plans as seen in Figure 5. The strategy and performance framework has four elements:

- Strategic goals,
- Objectives,
- Performance goals, including agency priority goals and cross-agency priority goals, and
- Annual performance indicators.

The internal implementation plans of individual offices and NASA Centers derive from this framework. Internal implementation plans guide each organization's activities toward achieving performance goals and annual performance indicators. As these plans are very technical, they generally remain internal to the Agency.

Figure 5: NASA's Strategy and Performance Framework



NASA's 2014 Strategic Plan reflects the top levels in the strategy and performance framework. The strategic goals and strategic objectives result from rigorous internal planning and external consultation with the Agency's stakeholders. Strategic objectives align with NASA's programs in the Congressional Justification.

The Agency's senior leaders set the Strategic Plan to reflect the Agency's direction and priorities, as agreed to with Congress and the Administration. Updates occur according to the timelines set by the GPRA Modernization Act. As such, the Agency plans to update its Strategic Plan again in 2018 with input from stakeholders, including Congress and OMB.

In accordance with the GPRA Modernization Act, NASA also delivers its agency priority goals with its Strategic Plan, to signify the importance of these ambitious, short-term goals in the overall achievement of NASA's strategy. Agency priority goals are discussed in more detail in "Management Priorities and Challenges."

ANNUAL PERFORMANCE PLANS

NASA's Annual Performance Plans set near-term targets for programs, projects, and organizations through performance goals, agency priority goals, cross-agency priority goals, and annual performance indicators. Performance goals, agency priority goals, and cross-agency priority goals focus on planned progress over the next two to four years. Annual performance indicators align to NASA's budget themes

and programs in the Congressional Justification. NASA publishes these measures in Annual Performance Plans, which also identify each responsible program or office. The FY 2014 and FY 2015 Performance Plans are included in the "Performance Reporting and Planning" section of this appendix. In its Annual Performance Plans, NASA also sets targets for mission support activities that sustain program and project activities. These performance commitments span the mission support portfolio in a range of areas, including human capital, information technology, infrastructure, and operating activities.

Using Evidence, Evaluation, and Research to Set Strategies and Measure Progress

NASA uses laws, executive orders, governance, and management best practices to promote a strong culture of results and accountability. NASA is committed to demonstrating that its programs and activities are managed and operated effectively and efficiently. This is done through a dynamic process of collecting evidence (data, research, or end product) and conducting rigorous independent evaluations of the evidence. These processes of verification and validation support strategic planning and determine general accuracy and reliability of performance information. These processes provide a level of confidence to stakeholders that the information the Agency provides is credible.

NASA's performance evaluation processes consist of internal and external reviews, including independent assessments and verification. NASA conducts evidence, evaluation, and research activities summarized below.

INTERNAL REVIEWS

- NASA monitors and assesses the engineering process of designing, building, and operating spacecraft and other major assets. Measures of performance for such investments focus on comparisons of actual versus planned schedule and cost. The Agency holds formal independent assessments as the project progresses through a series of gatekeeping KDPs. Such KDPs provide managers time to review all aspects of performance and thoughtfully promote (or delay, or even terminate) work on a project. These points can occur at any time of the year, depending on the formulation, development, or construction plan. NASA conducts additional set technical reviews between the KDPs to assess progress and continually monitor overall performance through the Baseline Performance Review.
- NASA's research programs often have broad goals, such as "understand the origin of the universe." To measure performance of these types of investments, NASA establishes and measures performance against smaller achievable goals to help demonstrate impact and overall contribution to the knowledge on the subject. It conducts assessments on these programs yearly, and lessons learned are captured as part of a yearly strategic review process.
- NASA assesses technology research and development (R&D) programs against incremental milestones (technology readiness levels, or TRLs). It regularly measures the TRL advancement of an individual technology investment, with overall technology portfolio assessments occurring each year.
- The Agency's operational or support and service type programs generally assess progress on meeting their specific objectives. They can measure performance against targets for output or capacity of the activity, quantifiable estimates of improvement with aggressive targets (e.g.,

reducing operating costs by two percent in two years), customer satisfaction, or routine on-site assessments. These assessments are often done annually.

- As part of end-of-fiscal year reporting, NASA's mission directorates and mission support offices within MSD and the Education office submit evidence supporting all performance measure ratings and rating explanations. This information is stored in the Performance Warehouse.

EXTERNAL REVIEWS AND ASSESSMENTS

- NASA relies on evaluations by the external community. Papers from NASA-supported research undergo independent peer-review for publication in professional journals. The Agency uses external peer review panels to objectively assess and evaluate proposals for new work in its science areas, technology development, and education. NASA often leverages internal and external evaluators to assess strategies, impact, implementation, efficiency and effectiveness, cost to benefit ratio, and relevance of work being performed. NASA relies on Senior Reviews by external scientists for advice on the most productive uses of funding for extended operations of science missions.
- Evaluations are a routine business activity in NASA. A series of decadal surveys and other analyses, conducted by the National Academies, help inform decisions about the Science Mission Directorate's investment portfolio and other aspects of NASA's R&D efforts. These external evaluations of user needs and requirements, in combination with performance assessments of on-going activities, help ensure that NASA's research priorities and investments stay current with the needs of the research community. The Technology Roadmaps are a similar planning tool, reflecting the R&D and technology needs of NASA, the government, and industry.

INNOVATIVE USE OF DATA FOR IMPROVED PERFORMANCE

NASA has answered the President's 2013 call to promote performance solutions that deliver a smarter, more innovative, and more accountable government for its citizens.[3] A critical component of this effort is strengthening NASA's ability to continually improve program performance by applying existing evidence about what works, generating new knowledge, and using experimentation to test new approaches to program delivery. NASA's strong commitment to this effort can be seen in a variety of a tools aimed at increasing its ability to use relevant performance information for budget and programming decisions.

In 2012, NASA implemented a Performance Management System comprised of the Performance Warehouse, a database designed in partnership with the Department of Treasury, and a companion system, the Performance Dashboard. These are internal NASA tools, but they produce reports that are publicly available at http://www.nasa.gov/news/budget/index.html. The Performance Warehouse standardizes data collection and archiving, streamlines performance reporting (both internally and to sites such as http://performance.gov/), and enables advanced data analytics. Beyond supporting NASA's internal management processes, these capabilities facilitate compliance with legislative and executive branch requirements, such as preparing machine-readable formats of performance information, and carrying out verification and validation of performance data. The Performance Dashboard automates ad hoc performance analysis, including production of mandated reports and plans such as the combined Annual Performance Plans and Annual Performance Report included in the "Performance Reporting and Planning" section in this appendix.

[3]OMB Memorandum-13-17, "Next Steps in the Evidence and Innovation Agenda," July 26, 2013.

NASA'S APPROACH TO PERFORMANCE MANAGEMENT

NASA is implementing an effort to enhance its program planning and control capability, including the use of earned value management, a project management technique for measuring project performance, progress, and risk. NASA collects program and project cost-estimating data, including project joint confidence levels, through its Cost Analysis Data Requirement (CADRe) and the One NASA Cost Engineering (ONCE) database. NASA is analyzing CADRe information collected in the ONCE database to gain insight into program and project growth over time. The objective is to use this analysis to improve cost estimation techniques and assessments of program and project planning and lifecycle reviews. NASA continues to strengthen the use of this tool.

PERFORMANCE MANAGEMENT

Once NASA organizations begin executing against commitments in the Strategic Plan and Annual Performance Plan, Agency managers and performance analysts monitor and evaluate performance. Internal reporting requirements drive the evaluation phase and call for analysis of results against planned performance. NASA continuously measures the Agency's progress in pursuit of its strategic goals, strategic objectives, and performance measures, and reports progress towards its targets to Congress and the public in the Annual Performance Report. The Agency shares its report combined with future Annual Performance Plans to provide a holistic view of NASA's performance.

The Agency monitors and evaluates performance toward plans and commitments using assessments, through which managers identify issues, gauge programmatic and organizational health, and provide appropriate data and evidence to NASA decision-makers. Assessments include:

- On-going monthly and quarterly analysis and reviews of Agency activities;
- Annual program/project assessments in support of budget formulation;
- Annual reporting of performance, management issues, and financial position;
- Strategic reviews of each strategic objective (starting in spring 2014);
- Periodic, in-depth program or special purpose assessments; and
- Recurring or special assessment reports to internal and external organizations.

QUARTERLY REPORTING

Each quarter, program officials submit to NASA management a self-evaluation that includes a rating for each performance measure and the supporting information that justifies the rating. The results of the quarterly performance assessments are presented to NASA's PIO and COO. This quarterly Executive Review keeps the PIO and COO informed of NASA's performance progress, allows them to make course corrections through the year to maintain alignment with strategic goals, and informs budget discussions. The PIO and COO review and approve the fourth quarter performance ratings before they are sent to OMB for review and subsequently published in the Agency Financial Report. The process culminates with the Annual Performance Report, comprised of the ratings (including any changes made after publication of the Agency Financial Report), rating explanations, and performance improvement plans.

ANNUAL ASSESSMENT RATING SCALES AND CRITERIA

NASA evaluates progress toward achieving performance goals and annual performance indicators against the Agency's standard rating scale, summarized in Figure 6. NASA bases performance ratings on internal assessments, mentioned above. External entities, such as scientific review committees and aeronautics technical evaluation bodies, validate the ratings prior to publication by NASA.

Figure 6: Performance Goal Rating Scale

Rating	Rating Criteria for Performance Goals
Green (On Track)	NASA achieved or expects to achieve the intent of the performance goal within the estimated timeframe. NASA achieved the majority of key activities supporting this performance goal.
Yellow (At Risk)	NASA expects to achieve the intent of the performance goal within the timeframe; however, there is at least one likely programmatic, cost, or schedule risk to achieving the performance goal.
Red (Not on Track)	NASA does not expect to achieve this performance goal within the estimated timeframe.
White (Canceled or Postponed)	NASA senior management canceled this performance goal and the Agency is no longer pursuing activities relevant to this performance goal or the program did not have activities relevant to the performance goal during the fiscal year.

In FY 2013, NASA began defining custom success criteria for each annual performance indicator. Previously, rating criteria were based on a program completion percentage: 100 percent for Green, above 80 percent for Yellow, and below 80 percent for Red. In the current system, mission directorates and mission support offices collaboratively define their own parameters for the color ratings (Green, Yellow, and Red) when the measures are developed. NASA uses these success criteria, combined with explanations of the ratings and sources provided by the mission directorates and mission support offices, to review and validate each rating.

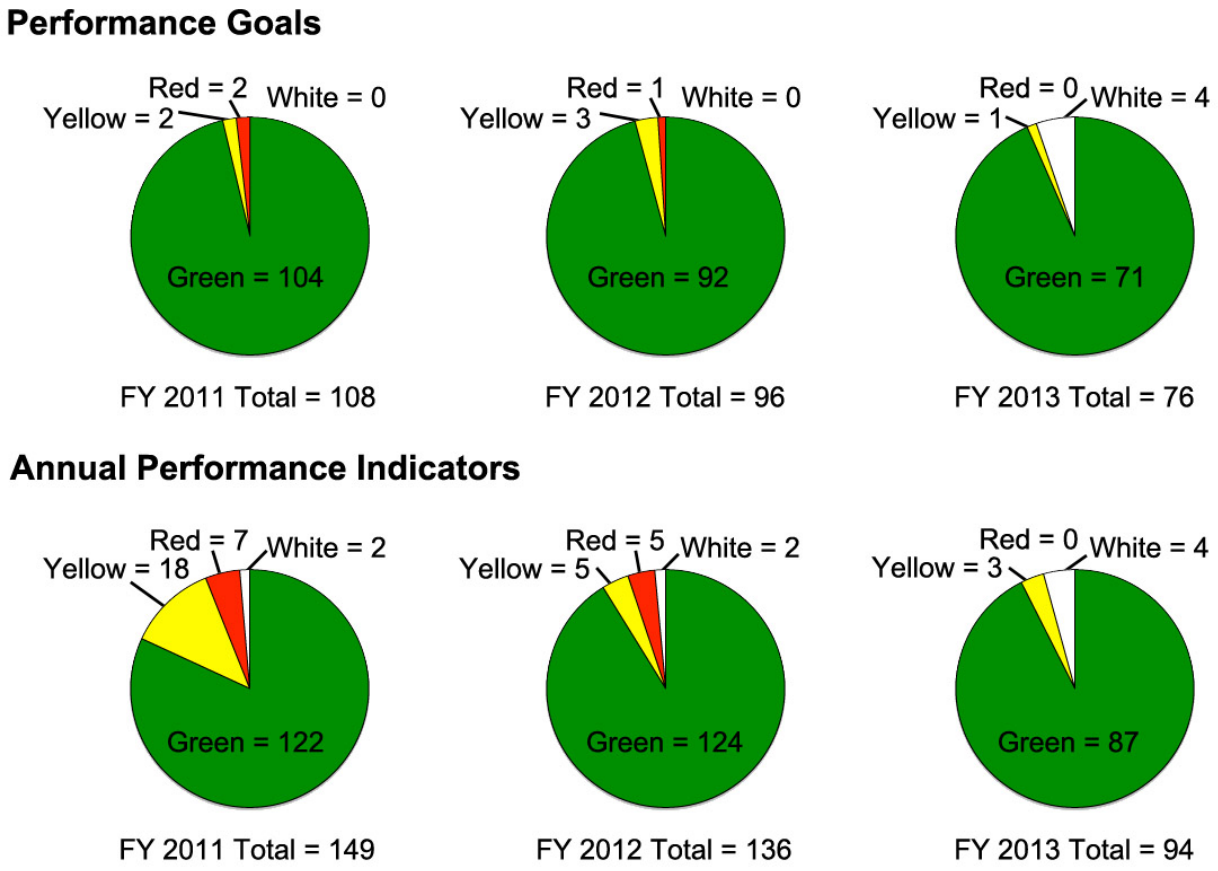
SUMMARY OF FY 2013 PERFORMANCE

NASA reviewed progress toward its 76 performance goals and 94 annual performance indicators for FY 2013. (Performance goals have a two- to five-year timeline.) The results in Figure 7 show actual performance for these measures in FY 2013 and the two prior fiscal years. For both performance goals and APIs, NASA met 93 percent of its targets in FY 2013, represented by Green ratings. Other highlights include:

- At the performance goal level, NASA met 96 percent of its targets in both FY 2011 and FY 2012, representing a slight decrease in FY 2013.
- At the annual performance indicator level, NASA met 82 percent of its targets in FY 2011 and 91 percent of its targets in FY 2012, a 13 percent improvement over the two-year period.
- In FY 2013, one percent of NASA's performance goals and three percent of its annual performance indicators fell below expectations, represented by Yellow and Red ratings. The remainder were rated White, which represents measures canceled by NASA senior management.

- Four percent of NASA's performance goals in FY 2011 and FY 2012 fell below expectations. Seventeen and seven percent of the annual performance indicators fell below expectations in FY 2011 and FY 2012, respectively.

Figure 7: Trends in Annual Performance, FY 2011-FY 2013



NASA rated one of its performance goals Yellow in FY 2013. The Space Network Ground Segment Sustainment (SGSS) project planned to replace or upgrade obsolete systems at the White Sands Complex. SGSS has not completed the cost and schedule portion of the Critical Design Review (CDR) for this activity; due to performance issues, this project is currently under review.

NASA rated three of its annual performance indicators Yellow in FY 2013. They are related to ISS, SGSS, and the Ice, Cloud, and Land Elevation Satellite (ICESat-2) activities. NASA rated ISS utilization Yellow, as it is currently at 60 percent utilization, below the 75 percent threshold set for FY 2013. (Utilization includes participation from three classes of participants: NASA research among different NASA programs; ISS National Laboratory operations that include other U.S. agencies and commercial research; and ISS International Partners like the European Space Agency, the Canadian Space Agency, Agenzia Spaziale Italiana, or Italian Space Agency, and Japan Aerospace Exploration Agency.) The SGSS project, which includes updates to the Tracking and Data Relay Satellites (TDRS) and ground segments in New Mexico and Guam, received a Yellow rating due to slower than planned progress towards its 2014 CDR (see the Yellow performance goal described above). ICESat-2 is designed to

measure ice sheets, clouds and aerosols, and land topography and vegetation. Due to erosion in cost and schedule performance, the program replaced the instrument management team. The new team will present an achievable plan at CDR, which is now in FY 2014. Based on this revised schedule, NASA rated the FY 2013 annual performance indicator Yellow. This is in accordance with the measure's success criteria for a Yellow rating, which states that it must be completed within the following fiscal year. In three of the last four years, NASA rated the ICESat-2 annual performance indicator Yellow.

NASA rated four performance goals and four annual performance indicators White, as canceled or postponed. FY 2013 budget levels were reduced for two information technology (IT) programs, which affected IT enterprise service commitments for FY 2014, and data center energy consumption commitments for FY 2015. NASA's Office of Education rated one performance goal and one annual performance indicator White, because continuing resolutions in FY 2012 and FY 2013 resulted in the untimely allocation of funds, hindering Education's ability to implement planned programmatic changes within the calendar year. The Office of Education also rated another performance goal and annual performance indicator White, because the measurement strategy was inadequate and did not have an accurate baseline. NASA will re-evaluate these measures in future Annual Performance Plans.

Management Priorities

NASA's management priorities are driven by both Federal priorities and Agency priorities. The President's management agenda and cross-agency priority goals link NASA's priorities to those of other agencies. NASA's agency priority goals are the top priorities for the next 18 months to two years. Since NASA is primarily a research and development (R&D) agency, the President's science and technology priorities also influence the Agency's management priorities.

CROSS-AGENCY PRIORITY GOALS

NASA is required by the GPRA Modernization Act to address cross-agency priority goals in the Agency Strategic Plan, the Annual Performance Plan, and the Annual Performance Report. For more information regarding the Agency's contributions to those goals, and progress, where applicable, refer to http://performance.gov.

NASA'S PRIORITY GOALS

NASA has completed two rounds of agency priority goals with the most recent round outlined in the table below. NASA selected these four agency priority goals in February 2012, and has achieved all of them.

AGENCY PRIORITY GOALS ACHIEVED IN FY 2013

Retired Agency Priority Goal	Responsible Organization	Status
By September 30, 2013, NASA will assess the biological potential of at least one target environment on Mars by obtaining chemical and/or mineralogical analysis of multiple samples of its surface.	Science Mission Directorate, Mars Exploration Program	**Completed**
By the end of FY 2013, NASA will complete at least three flights delivering research and logistics hardware to the ISS by U.S. developed cargo delivery systems.	Human Exploration Operations Mission Directorate, International Space Station Program	**Completed**
By September 30, 2013, NASA will finalize cross-program requirements and system definition to ensure that the first test flight of the Space Launch System (SLS) and Multi-Purpose Crew Vehicle (MPCV) programs is successfully achieved at the end of 2017 in an efficient and cost effective way.	Human Exploration Operations Mission Directorate, Exploration Systems Division	**Completed**
By September 30, 2013 document the maturation of new technologies by completing 4,065 technology-related products, including patents, licenses, and mission use agreements.	Office of the Chief Technologist	**Completed**

In FY 2013, NASA achieved all of its agency priority goals. A brief summary of progress is provided below, and more details are available at http://goals.performance.gov/agency/nasa.

NASA successfully launched the Mars Science Laboratory (MSL) spacecraft in November 2011. The rover Curiosity touched down on Mars on August 6, 2012, (UTC) to begin its two-year investigation. The MSL spacecraft that carried Curiosity succeeded in every step of the most complex landing ever attempted on Mars. The landing completed the most hazardous phase of the project and began MSL's exciting mission in pursuit of its science objectives. All 10 of Curiosity's highly advanced instruments have operated as expected or better on the surface of Mars. This performance led to the major discovery of conglomerates: physical evidence of an ancient riverbed on Mars, proof that the region of Gale Crater had liquid water, which is a major finding in assessing habitability. Additional analyses including the use of two instruments in Curiosity's onboard analytical laboratory have shown the area of Glenelg/Yellowknife Bay to have once been able to support microbial life.

NASA implemented the U.S.-developed private commercial cargo delivery systems during FY 2013 through the competitively selected Commercial Re-Supply Services contracts awarded to Space Exploration Technologies (SpaceX) and Orbital Sciences Corporation. This NASA initiative is helping to develop a robust U.S. commercial space transportation industry with the goal of achieving safe, reliable and cost-effective transportation to and from low Earth orbit to meet the needs of both commercial and Government customers. By the end of 2013, NASA completed at least three private commercial cargo delivery flights to the International Space Station (ISS) by SpaceX and Orbital Sciences Corporation. The first commercial cargo delivery flight, SpaceX-1, launched and delivered cargo to the ISS October 7, 2012, returning to Earth October 28, 2012. The second cargo delivery flight, SpaceX-2 launched and delivered cargo and science experiments to the ISS March 1, 2013, and returned to Earth March 25, 2013. The third demonstration mission was launched on September 18, 2013, and docked with the ISS on September 29, 2013 delivering 1,300 pounds of cargo, including student experiments, food, and clothing to the ISS.

NASA successfully met the Exploration Systems Development agency priority goal in the third quarter of FY 2013 and continues to make significant progress toward the first test flight of the Space Launch System (SLS) and Orion Multi-Purpose Crew Vehicle (MPCV) in 2018. The Exploration Systems Integration (ESI) Systems Definition Review (SDR), which finalized the cross-program requirements and system definition, was successfully completed and Agency leadership concurred with the review outcome on April 16, 2013.

NASA has exceeded its two-year agency priority goal target to develop and transfer technology, as demonstrated by achieving a total of 5,991 indicators, well above its initial target of 4,065. These indicators included new technology reports, software usage agreements, filing of new patent applications, technology licenses, documented technology spinoffs and NASA technology mission use documents.

NASA'S FY 2014-FY 2015 AGENCY PRIORITY GOALS

NASA set four new agency priority goals starting in FY 2014. More information on this latest set of goals can be found at http://goals.performance.gov/agency/nasa.

Agency Priority Goal	Responsible Organization
By September 30, 2015, NASA will increase the utilization of the International Space Station internal and external research facility sites with science and technology payload hardware to 70 percent.	Human Exploration Operations Mission Directorate, International Space Station Program
By September 30, 2015, NASA will complete the Space Launch System, Orion, and Exploration Ground Systems Critical Design Reviews (CDRs), allowing the programs to continue to progress toward Exploration Mission (EM)-1 and EM-2 missions.	Human Exploration Operations Mission Directorate, Exploration Systems Division
By September 30, 2015, the Commercial Crew Program will complete the first phase of certification efforts with Commercial Crew Transportation partners, and will make measurable progress toward the second certification phase with industry partners while maintaining competition.	Human Exploration Operations Mission Directorate, Commercial Crew Program
By October 2018, NASA will launch the James Webb Space Telescope, the premier space-based observatory. To enable this launch date, NASA will complete the James Webb Space Telescope primary mirror backplane and backplane support structures and deliver them to the Goddard Space Flight Center for integration with the mirror segments by September 30, 2015.	Science Mission Directorate, James Webb Space Telescope Program

PRESIDENT'S MULTI-AGENCY SCIENCE AND TECHNOLOGY PRIORITIES

Introduction

The innovative science and engineering research done at NASA is a valuable source of new knowledge that drives important developments in fields ranging from telecommunications to medicine. These technical innovations create entirely new industries that require highly skilled employees and high-wage jobs. This year, the President put forth a list of science and technology priorities for all Federal agencies in order to focus the Nation's efforts in scientific discovery, technological breakthroughs, and innovation. The R&D supporting science and technology research are vital for responding to the challenges and opportunities of the twenty-first century. NASA conducts Agency-specific, mission driven research, which frequently overlaps with the multi-agency research activities identified by the President.

NASA's Annual Performance Plans set short-term targets for programs, projects, and organizations by establishing performance measures, including performance goals, agency priority goals, and annual performance indicators. Performance goals and agency priority goals focus on planned progress over the next 18 months to five years and address more broadly defined activities. Performance measures align to NASA's budget themes and programs in the Congressional Justification. NASA performs many activities that support the President's science and technology priorities, described in greater detail below. NASA selects key performance measures to report externally, so these activities may not be specifically called out in the Agency's performance plans. Nonetheless, NASA's performance measures do indicate alignment with the President's science and technology priorities and illustrates NASA's contribution to the multi-agency research activities identified by the President. The detailed analysis follows the examples below.

The President identified nine priorities that require investments in R&D. Support for activities such as technology transfer, use of R&D facilities, scientific data collection and management, and science, technology, engineering, and mathematics (STEM) education enable a robust science and technology

enterprise. Cooperation among multiple Federal agencies also is a key to successfully enabling such an enterprise. For a complete description of the President's science and technology priorities, see the President's *Strategy for American Innovation* and Office of Management and Budget Memorandum-13-16.

As one of the primary Federal agencies responsible for research and development, NASA's activities in the Annual Performance Plan align with eight of the nine President's science and technology priorities. The eight priorities are described below, with examples of NASA activities that support each priority. NASA does not directly support the ninth priority, Research and Development for National Security Missions, as directed in The National Aeronautics and Space Act, Public Law No. 111-314, Sec. 20102 (b). While NASA research may benefit national security, it is not the primary goal of NASA activities.

Example NASA Activities Supporting the President's Multi-Agency S&T Priorities

Advanced Manufacturing

The President directs Federal agencies to give priority to those programs that advance the state of the art in manufacturing, with particular emphasis on government-industry-university partnerships and enabling technologies that benefit multiple sectors. The Space Act states that part of NASA's mandate is, "[t]he preservation of the United States preeminent position in aeronautics and space through research and technology development related to associated manufacturing processes."

Accordingly, NASA is represented in the public-private partnership of the National Manufacturing Initiative and its signature effort, the National Network for Manufacturing Innovation (NNMI), by the Space Technology Mission Directorate (STMD). Through Space Technology Research Grants, Centennial Challenges, and Game Changing Development, STMD contributes to the acceleration of technology development pursued within the Institutes for Manufacturing Innovation. The objective of NASA's participation in the NNMI is to increase the number and diversity of collaborators working to address the manufacturing challenges within space applications (both for space and in space manufacturing) and to contribute to modernizing the overall aerospace industry. In addition, Game Changing Development supports NASA's role in the National Nanotechnology Initiative to coordinate NASA's investment portfolio with other government agencies. NASA supports nanotechnology research and applications for aeronautics and space, focused primarily on reducing vehicle mass and improving reliability through the development of nanotube-based, ultra-high strength composite structures, and nanotechnology derived sensors.

NASA has a long history of working with industry partners in the field of advanced manufacturing. Several NASA Centers are on the cutting edge of manufacturing technology development and have worked to create and maintain these partnerships to accelerate technology useful to NASA. Examples include the National Center for Advanced Manufacturing in Louisiana and the NASA/Commonwealth Center for Advanced Manufacturing partnership in Virginia. In addition, NASA is partnering with Boeing to build the first ever 16.5-foot (5-meter) diameter composite cryotank using an out of autoclave system. NASA also has partnered with Lockheed Martin to develop advanced near net shape technologies for metallic tanks. NASA is leading the way in additive manufacturing (sometimes called three dimensional printing) in space. NASA, in collaboration with Made In Space, LLC, will launch a printer to the International Space Station.

Clean Energy

The President states that national agencies should give priority to R&D to advance clean-energy solutions. Such solutions will help reduce pollution, greenhouse-gas emissions, and dependence on oil while creating high-wage, highly-skilled, clean-energy jobs and businesses. Improving the efficiency, sustainability, and cost effectiveness of transportation alternatives, and also improving energy efficiency in industry, buildings, and manufacturing, provides the United States with the ability to lead the world in clean-energy technology. Among the Agency's investments in clean-energy solutions, NASA's Alternative Fuel Effects on Contrails and Cruise Emissions (ACCESS) flight program studies the effects of alternate biofuel on aircraft engine performance, emissions and aircraft-generated contrails at altitude. ACCESS's goal is to reduce aviation's impact on the environment by using alternate biofuels (see AR-15-4).

Global Climate Change

Within the White House's U.S. Global Change Research Program, the President instructs agencies to continue making progress toward fulfilling the 2012-2021 Strategic Plan. NASA's FY 2015 priority areas include better understanding of the causes and consequences of drought and the interaction of global-change impacts in the Arctic with climate in the mid-latitudes. NASA's Earth science efforts are the front line of the Nation's research into global climate change. New evidence from NASA-led studies indicates that global warming may increase the risk for extreme rainfall and drought. New studies of glaciers worldwide using observations from NASA satellites help to resolve differences in estimates of how fast glaciers are disappearing and contributing to sea level rise. A NASA-led study of atmospheric-river storms from the Pacific Ocean may help scientists better predict major winter snowfalls that hit West Coast mountains and lead to heavy spring runoff and occasional flooding (see ES-15-4 and ES-15-7).

R&D for Informed Policy-making and Management

To help the Nation become more resilient to natural and technological disasters, agencies should focus investments on improving the delivery of information that enhances the understanding of the natural processes that produce hazards. Timely delivery of such information can help promote behavior based on a better understanding of natural and technological hazards. NASA provides timely data on environmental disasters through a combination of the Agency's unique resources, which allows leaders, policy-makers, and responders to make decisions based on real-time scientific data. When super-typhoon Haiyan struck the central Philippines November 8, 2013, NASA satellites provided data to meteorologists at the Joint Typhoon Warning Center, who were updating forecasts for the typhoon. NASA's TRMM satellite captured visible, microwave and infrared data on the storm. Officials used a space-based map, generated by scientists at NASA's Jet Propulsion Laboratory in collaboration with the Italian Space Agency, in disaster response efforts. Haiyan made landfall as an extremely powerful super typhoon, perhaps the strongest ever recorded at landfall. With sustained winds estimated at 195 mph (315 kph) by the Joint Typhoon Warning Center, it was equivalent to a Category 5 hurricane (see ES-15-2 and ES-15-8).

Information Technology

The President instructed agencies to give priority to investments that address the challenges and opportunities of the big data revolution, represented by the fast-growing volume of large and complex collections of digital data. Investments in big data can advance agency missions and further scientific discovery and innovation, but require appropriate privacy protections for personal data. The NASA Earth

Exchange is a collaboration and analytical platform that combines state-of-the-art supercomputing, Earth system modeling, workflow management, and NASA remote-sensing data, enhancing research and educational opportunities for the U.S. geoscience community by promoting community-driven research, innovation, and collaboration (see ES-15-10).

Innovation in Biology and Neuroscience

The President instructed agencies to give priority to R&D investments that have the potential to foster biological innovations in health, energy, and agriculture. The President's priorities place emphasis on technologies used for the design of biological systems, understanding systems biology, and high throughput biology. NASA engages in a robust biological research program on Earth and in space. Research aboard the International Space Station, a U.S. Federal laboratory, includes experiments in biology, biotechnology, and human research. NASA sponsors projects like the Robotic Gardening System, which is part of a graduate course sponsored by NASA and the National Space Grant X-Hab Academic Challenge. Also, biological research at Kennedy Space Center examines how Alzheimer's and other brain diseases occur (see ISS-15-7). NASA also sponsors the Space Synthetic Biology project through Game Changing Development within Space Technology.

STEM Education

The President is committed to improving STEM education and to ensuring that Federal resources are aligned and directed to improve STEM outcomes and prepare a strong STEM capable workforce. To support these goals, the Administration has proposed a bold STEM education reorganization and a comprehensive five-year Strategic Plan; NASA is aligning its STEM education investments accordingly. NASA also works to ensure that programs are designed to identify and effectively meet the needs of end-users—students, teachers, schools, districts, and postsecondary institutions—while continuing to reduce STEM-education program fragmentation (see ED-15-1 and ED-15-5). NASA's Summer of Innovation program challenges middle school students across the United States to share in the excitement of scientific discovery and space exploration through unique, NASA-related STEM opportunities (see ED-15-5).

Innovation and Commercialization

The President instructed agencies to promote innovation and commercialization from Federal R&D investments. Promotional efforts may include support for inducement prizes, fostering the transition of emerging scientific discoveries into engineering disciplines, early-stage technology development, university-industry-government-laboratory partnerships, leveraging of focused and coordinated investments in the Small Business Innovation Research program, and efforts to better link graduate and postdoctoral training with both private and public-sector workforce needs. As part of its mandate in the Space Act, NASA is instructed to, "seek and encourage, to the maximum extent possible, the fullest commercial use of space." In its effort to uphold this mandate, NASA sponsors advanced aerospace system concept studies and foundational technology development efforts on a wide range of topics such as asteroid detection, characterization, and mitigation, as well as in-situ resource utilization, proximity operations, autonomous robotics, and radiation mitigation. As an entry point of NASA's pipeline of revolutionary concepts and early stage technologies, Space Technology supports early-stage development through Space Technology Research Grants, NASA Innovative Advanced Concepts, the Center Innovation Fund, and Centennial Challenges (see ST-15-1, ST-15-2, ST-15-6).

Mapping Performance Plans to the President's Multi-Agency S&T Priorities

NASA's FY 2014 and FY 2015 Performance Plans contain many measures that support the President's science and technology priorities. The following table highlights the performance goals and annual performance indicators in FY 2014 and FY 2015 that clearly support the priorities. Measures that do not have a clear link are not listed, even though they may support the priorities indirectly.

Strategic Objective	FY 2014 Performance Goal	FY 2014 Annual Performance Indicator	FY 2015 Performance Goal	FY 2015 Annual Performance Indicator
President's Science and Technology Priority Advanced Manufacturing				
1.1	1.1.1	ESD-14-1	1.1.1	ESD-15-1
		ESD-14-2		ESD-15-2
		ESD-14-3		ESD-15-3
	1.1.2	ERD-14-2	1.1.2	ERD-15-1
		ERD-14-3		ERD-15-2
		ERD-14-6		ERD-15-3
	1.1.3	ERD-14-4		
			1.1.5	ERD-15-4
1.2	1.2.3	ISS-14-3	1.2.3	ERD-15-5
	1.2.5	ISS-14-6	1.2.5	ISS-15-5
1.3	1.3.3	ISS-14-2	1.3.3	ISS-15-8
1.5			1.5.6	PS-15-8
1.6	1.6.1	JWST-14-1	1.6.1	JWST-15-1
1.7	1.7.2	ST-14-2	1.7.2	ST-15-3
	1.7.3	ST-14-3	1.7.3	ST-15-4
		ST-14-4		ST-15-5
President's Science and Technology Priority Clean Energy				
2.1	2.1.3	AR-14-5	2.1.3	AR-15-3
		AR-14-7		
	2.1.4	AR-14-13	2.1.4	AR-15-4
3.1	3.1.7	AMO-14-20	3.1.7	AMO-15-10
		AMO-14-22		AMO-15-12

MANAGEMENT PRIORITIES AND CHALLENGES

Strategic Objective	FY 2014 Performance Goal	FY 2014 Annual Performance Indicator	FY 2015 Performance Goal	FY 2015 Annual Performance Indicator
President's Science and Technology Priority Global Climate Change				
2.2	2.2.1	ES-14-1	2.2.1	ES-15-1
	2.2.3	ES-14-6	2.2.3	ES-15-3
	2.2.4		2.2.4	ES-15-4
				ES-15-5
		ES-14-7		
				ES-15-6
	2.2.5	ES-14-9	2.2.5	ES-15-7
President's Science and Technology Priority R&D for Informed Policy-making and Management				
1.4	1.4.3	HE-14-7	1.4.3	HE-15-3
2.1			2.1.1	AR-15-1
	2.1.2	AR-14-12	2.1.2	AR-15-2
	2.1.3	AR-14-9		
	2.1.6	AR-14-8	2.1.6	AR-15-7
2.2	2.2.2	ES-14-3	2.2.2	ES-15-2
	2.2.6	ES-14-11	2.2.6	ES-15-8
President's Science and Technology Priority Information Technology				
2.2	2.2.7	ES-14-14	2.2.7	ES-15-10
3.3	3.3.1	AMO-14-17	3.3.1	AMO-15-16
President's Science and Technology Priority Innovation in Biology and Neuroscience				
1.2	1.2.3	ISS-14-3	1.2.3	ISS-15-3
	1.2.5	ISS-14-5	1.2.5	ISS-15-4
		ISS-14-6		ISS-15-5
		ISS-14-8		ISS-15-7
President's Science and Technology Priority Science, Technology, Engineering, and Mathematics (STEM) Education				
2.4	2.4.1	ED-14-1	2.4.1	ED-15-1
	2.4.2	ED-14-6	2.4.2	ED-15-2
			2.4.3	ED-15-3
	2.4.4	ED-14-5	2.4.4	ED-15-4
	2.4.5	ED-14-8	2.4.5	ED-15-5

Strategic Objective	FY 2014 Performance Goal	FY 2014 Annual Performance Indicator	FY 2015 Performance Goal	FY 2015 Annual Performance Indicator
President's Science and Technology Priority Innovation and Commercialization				
1.2	1.2.5	ISS-14-7	1.2.5	ISS-15-6
1.3	1.3.1	CS-14-1	1.3.1	CS-15-1
		CS-14-2		
	1.3.2	CS-14-4	1.3.2	
		CS-14-5		CS-15-3
1.7	1.7.1	ST-14-1	1.7.1	ST-15-1
				ST-15-2
	1.7.3	ST-14-5	1.7.3	ST-15-6
2.1	2.1.1	AR-14-3		
		AR-14-4		
	2.1.3	AR-14-10		
		AR-14-11		
	2.1.5	AR-14-1	2.1.5	
				AR-15-5
	2.1.6	AR-14-2	2.1.6	
				AR-15-6

LOWER-PRIORITY PROGRAM ACTIVITIES

The President's Budget identifies the lower-priority program activities, where applicable, as required under the GPRA Modernization Act, 31 U.S.C. 1115(b)(10). The public can access the volume at http://www.whitehouse.gov/omb/budget.

Management Challenges

NASA leverages its internal reviews to identify management challenges, but also looks to external opinions. NASA's Inspector General provides a list of the top management and performance challenges annually. The Government Accountability Office performs numerous audits of NASA activities, but the High Risk report addresses management challenges specifically.

RESPONSE TO OIG MANAGEMENT CHALLENGES

Each fiscal year, as required by the Reports Consolidation Act of 2000, NASA's Office of Inspector General (OIG) issues a document summarizing what the Inspector General considers to be the most serious management and performance challenges facing the Agency and briefly assesses the Agency's progress in addressing those challenges. The letter and NASA's comments on each management challenge raised by OIG are located in NASA's FY 2013 Agency Financial Report. This listing of

MANAGEMENT PRIORITIES AND CHALLENGES

NASA's Top Management and Performance Challenges is a key input to the Agency's leadership when evaluating strategies and making adjustments to strategic and performance plans.

In the 2013 letter, OIG identified an overarching challenge shared by all Federal agencies regarding the difficulties of management planning in an environment of increasing fiscal uncertainty. NASA is operating in an uncertain budget environment. The Agency submitted a budget that aligns to the President's request of $17.7 billion in FY 2014. In addition to this overarching challenge, OIG also identified a list of nine top challenges facing the Agency in FY 2014. The following list of challenges includes a summary of NASA's efforts to use the OIG findings in a constructive way to improve the Agency. While the summary below is based on "Management's Response to the Office of the Inspector General's Memorandum on the Top Management and Performance Challenges of NASA," as published in the FY 2013 Agency Financial Report, NASA has updated information since the report's publication in early FY 2014.

1. Considering Whether to Further Extend the Life of the International Space Station

The first management challenge identified by OIG was the question of whether to further extend the life of the International Space Station (ISS) beyond 2020, and the uncertainty presented by the lack of a decision. The President recently announced his decision to extend operations of ISS until at least 2024. Extending the life of the International Space Station to at least 2024 will advance the Nation's goals in space and benefit humanity on Earth. Extending ISS will enable the development of a stable commercial space industry in transportation of crew and cargo to low Earth orbit; enable significantly more research opportunities that will benefit humanity through research in fundamental physics, biology, and medicine; and expand knowledge of Earth, the solar system, and the universe. Most importantly, operation of ISS to at least 2024 is critical to the future human exploration of deep space.

2. Developing the Space Launch System, Orion, and Exploration Ground Systems

The Exploration Systems Development (ESD) division is aggressively preparing the Space Launch System (SLS), Orion, and the Exploration Ground Systems that will provide the foundational elements for deep space exploration. NASA is targeting FY 2018 for the first launch of the combined SLS and Orion vehicles. ESD has established a proactive affordability initiative that each program has implemented to find innovative and effective ways to avoid the need for greater expenditures in the development phases of each of the programs. NASA is adapting existing flight and ground hardware, facilities, and designs in the ESD division in an effort to reduce the overall cost of design reviews, testing, and certification.

3. Securing Commercial Crew Transportation Services

OIG identified four challenges to NASA's Commercial Crew program (CCP). The first challenge was unstable funding. For the past several years, CCP received in appropriations significantly less funding than the President's budget requested, resulting in delays of the expected completion of the commercial crew development phase until 2017. Moreover, OIG found that NASA has yet to project the total amount of funding required by year, which makes it difficult for NASA to manage its wider portfolio of spaceflight programs and reduces the transparency of the Program's budget submissions. The final appropriation in FY 2014 for CCP was $696 million. NASA continues to strive for transparent and comprehensive justifications for the budget requests. OIG next identified inadequate integration of NASA's cost estimates with the CCP schedule. NASA has developed the Agency's program costs for

CCP on a year-by-year basis throughout its life, which informs the Agency's annual President's Budget Request. NASA will continue to employ a series of reviews, involving both internal and external checks to continually examine the Commercial Crew Program's status. OIG next identified delays in certification guidance from NASA to its commercial partners as a challenge. NASA's Certification Products Contracts initially involved over 400 deliverables spanning three different partners with varying designs and processes and formats resulting in thousands of NASA comments in response. CCP was successful in dispositioning all deliverables by the end of September 2013, which fully met the need for timely response as part of the overall CCP acquisition strategy. In addition, CCP conducted a workshop to evaluate the lessons learned from the initial round of deliverables and developed process improvements to ensure timely disposition of deliverables in the future. The final challenge identified by OIG was the difficulty presented in coordinating with other Federal agencies. NASA and the Federal Aviation Administration have ongoing and comprehensive interactions regarding crew/public safety requirements and regulations. OIG also recommended, and the agency is pursing, an increased level of collaboration with the United States Air Force.

4. Ensuring Continued Efficacy of the Space Communications Network

In 2006, NASA initiated the Space Communications and Navigation (SCaN) program to create an integrated Agency-wide space communications and navigation architecture. The evolution of the integrated system will take place in phases. Currently, SCaN is adding new capabilities that extend the functionality of the program's networks, including the Near Earth Network, the Space Network, and the Deep Space Network. The new capabilities will be incorporated into the integrated architecture. SCaN also manages the Spectrum Management Program for the Agency, including discussions with other space-faring nations regarding spectrum allocation. With a planned FY 2014 budget of $538.5 million, the networks that make up SCaN will initially remain independent.

NASA has plans to upgrade its Space Network through a Space Network Ground Segment Sustainment (SGSS) project. The purpose of the SGSS project is to implement a modern ground station that will enable delivery of high quality services to the Space Network community while significantly reducing operations and maintenance costs. The Space Network is also in the process of upgrading and replenishing the Tracking and Data Relay Satellite fleet of satellites, many of which are operating well beyond their planned lives. NASA is upgrading the Deep Space Network, which is run from three ground-based sites (Goldstone, California; Madrid, Spain; and Canberra, Australia). NASA believes the upgrades would support a greater number of missions and spacecraft as well as the increased complexity and data transfer requirements of those missions.

5. Maintaining Cost and Schedule for the James Webb Space Telescope

Since the September 2011 rebaseline, the James Webb Space Telescope (JWST) program has stayed within its approved budget (both profile and total life cycle) and has maintained its October 2018 launch readiness date. Several strategies are employed to maintain cost and schedule performance of JWST. First, NASA established a dedicated program office at Headquarters, headed by a program director that reports to the NASA Associate Administrator. Second, this new program office conducts greatly increased communication efforts, including daily and weekly working discussions between program and project officials, weekly discussions with senior NASA Headquarters officials, participation by program officials in monthly project technical and programmatic reviews, and quarterly progress reviews with senior NASA officials and senior industry officials. Third, NASA expanded its cost and schedule analyses that are performed and subsequently reported by the program and project offices, all to provide

additional information for decision making by program and project management. Fourth, program and project managers prepare a substantial set of annual milestones prior to each fiscal year. These milestones focus on the most difficult and important work by all JWST-supporting organizations for the upcoming fiscal year, and managers track progress against the milestones for reporting internally to NASA and to all external stakeholders in the government and scientific community.

6. Managing NASA's Infrastructure and Facilities

OIG identified five challenges in NASA's management of infrastructure and facilities, the first of which was the effect of changes in the Nation's space policy on the strategy for demolition or disposal of unneeded facilities. NASA's demolition program has been active since 2004 and currently has demolition projects scheduled through 2017. The near-term focus is to demolish those facilities that supported the Space Shuttle Program but are no longer needed by the Agency and are not being modified for future needs. In addition, NASA will demolish several technical facilities that the Agency no longer needs or will be retiring in the near future. As part of its budget formulation process, NASA assesses its infrastructure annually to identify facilities that should be included in the demolition program. Each year, NASA identifies 20-50 sites for demolition. The next challenge OIG identified was NASA's decentralized approach to managing its infrastructure. OIG said this creates a rivalry between the Centers that leads them to build or preserve facilities that duplicate capabilities available elsewhere in the Agency or lack an identified mission use. NASA is implementing a strategy of refurbishing, consolidating, or replacing key facilities, which has already achieved financial savings. NASA estimates that it will reduce administrative space by 398,000 square feet from a 2012 baseline by 2015. OIG next addressed the challenge of property partnerships. OIG found that 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 it does not need. NASA is partnering with the private sector and with other Federal agencies to make underutilized NASA facilities available to others. The OIG letter also identified the challenge of using Federal transfer of budget authority to defray some of the costs of maintaining NASA's infrastructure. NASA is working with the General Services Administration to identify underutilized spaces at NASA Centers and then to transfer those assets to other Federal agencies. The final infrastructure challenge identified by OIG was adequately maintaining facilities in an environment of rising utility, labor, and material costs and decreasing facility budgets. NASA relies on reliability-centered maintenance (RCM) of critical systems. RCM is an ongoing process that gathers data from operating systems performance and uses this data to improve design and future maintenance. RCM uses predictive testing techniques to identify conditions that could lead to failure or accelerated deterioration.

7. Overhauling NASA's Information Technology Governance Structure

The OIG found that NASA needs to implement an effective information technology (IT) governance approach that appropriately aligns authority and responsibility commensurate with the Agency's overall Mission. The NASA Chief Information Officer (CIO) now reports directly to the Administrator. In the first quarter of FY 2014, the Mission Support Council approved a Phase 2 Information Technology Governance model decision package. OCIO will conduct an Agency-wide Six Sigma Kaizen event to improve IT procurement approval processes with corresponding financial system changes. This will ensure alignment of IT procurements with Agency strategic direction. OCIO assessed and identified improvements for IT governing boards. Upon approval in early FY 2014, OCIO will update board charters and communicate the streamlined board structure to Agency stakeholders. OCIO will work with mission directorates to develop common roles and responsibilities and enhance coordination. In FY 2014,

OCIO will consider the results of the IT assessment and implement recommendations as appropriate to ensure organization and governance to meet NASA's IT needs.

8. Ensuring Security of Agency Information Technology Systems

The OIG letter stated that, to protect the Agency against inevitable cyberattacks, NASA must ensure that its IT systems and associated components are regularly safeguarded, assessed, and monitored. To this end, NASA's OCIO continues to complete major milestones toward its comprehensive, risk-based IT security program implementation based on continuous monitoring and use of automated tools. To meet the changing threat and risk environment, OCIO will: update NASA's information security policies; develop and test a real-time IT security dashboard reporting tool; transition from manually generated to dynamically generated System Security Plans; and develop a framework for an IT Security Tools Repository to leverage enterprise IT security tools and services. OCIO will identify mandatory security controls mapped to the SANS Institute/Federal Bureau of Investigation Annual Top 20 Critical Controls. To address Web-related vulnerabilities, OCIO will implement the Web Application Security Program. OCIO will mature the NASA Security Operations Center threat assessment and incident response capabilities, specifically introducing the Security Incident Management (SIM) system. The SIM system is an automated analysis capability that allows IT security professionals to focus on true (rather than false positive) security issues to better protect NASA's information systems.

9. Ensuring Integrity of the Contracting and Grant Process

Approximately 80 percent of NASA's $17.7 billion FY 2012 budget was spent on contracts to procure goods and services and provide funding to grant and award recipients. OIG found that, 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. NASA has made significant improvements in the oversight and operation of the Small Business Innovation Research (SBIR) program to reduce the likelihood of fraud, waste, and abuse. The NASA Shared Services Center implemented a new process highlighting Contracting Officer Representative involvement in reviewing and accepting deliverables and certification before payment is made. The SBIR Program Office also implemented the recommendations articulated in the OIG's January 2011 and February 2012 reports.

In response to the OIG's April 8, 2013, report on Energy Savings Performance Contracts (ESPCs), NASA has aggressively pursued a range of corrective actions to update requirements, training, and oversight of ESPCs across the Agency. Over time, increased experience with these contracts has expanded the Agency's perspective of earlier standards.

PERFORMANCE REPORTING AND PLANNING

The following pages represent NASA's combined Annual Performance Report and Annual Performance Plan. The combined report shows up to six years of historical performance alongside two years of future plans. In addition, the combined report is aligned with NASA's 2014 Strategic Plan. Many details on NASA's new strategic goals and strategic objectives are available in the 2014 Strategic Plan and not repeated here. The focus of the combined report is on recent performance from the last fiscal year and plans for the next two years.

Presenting the Annual Performance Report and Annual Performance Plan information together allows a unique opportunity to see the trend across multiple years within a program and the tie between multi-year performance goals and the annual components of these. Multi-year performance trends are incorporated into the FY 2015 Performance Plan, starting with the currently reported year of FY 2013 and spanning backward for up to five years. NASA's method for trending multi-year performance data is to show the linkages between measures tracking similar data and annual progress for follow-on program activities. Linked measures, even if revised in subsequent years, are shown as related performance data. They are not meant to show back data for measures written exactly the same. In some cases, measures have been updated over the years to improve accuracy and data quality.

For detailed information on performance ratings and measures from FY 2008 to FY 2012, go to http://www.nasa.gov/about/budget/PAR_Reports.html.

The combined report is organized by strategic goal, followed by an overview of each strategic objective. NASA summarizes FY 2013 performance for each multi-year performance goal, and whether there is planned performance against these in FY 2014 and/or FY 2015. The performance goal summary is followed by:

- The annual performance indicators associated with the performance goal;
- The FY 2013 ratings for the performance goal, its supporting annual performance indicators, and the performance measures for the past five fiscal years (if applicable);
- The Annual Performance Plan for FY 2014 and FY 2015; and
- If an FY 2013 annual performance indicator was not met, an explanation for why performance was less than planned and plans for improvement.

Because NASA's plans for FY 2014 and FY 2015 are aligned to the 2014 Strategic Plan, many performance goals and annual performance indicators from the 2011 Strategic Plan do not carry forward. After Strategic Goal 3, NASA lists the FY 2013 performance for performance goals and annual performance indicators that are retired with the old Strategic Plan in a subsection called, "Retired FY 2013 Measures: Reported Performance."

Figure 8 is an annotated sample from the combined Annual Performance Report and Annual Performance Plan.

Figure 8: Annual Performance Plan/Annual Performance Report Sample

FY 2014 and FY 2015 performance goal number and description

Multi-year Performance Goal

FY 2015 and FY 2014 1.2.3: By FY 2018, replace aging Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).

FY 2013 5.4.3.3: By FY 2018, replace aging and obsolete Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).

FY 2013 number, in the previous strategy and performance framework, and description

Performance goal current and past ratings

Performance Trending:

FY 2011	FY 2012	FY 2013
5.4.3.3 Green	5.4.3.3 Green	5.4.3.3 Green

Explanation of performance goal and its rating

FY 2013 Performance Goal Progress Summary

DSN is an international network of antennas that supports interplanetary spacecraft missions, space-based telescopes, and some selected Earth-orbiting science missions. To meet ongoing demand for deep space communication services, it is replacing its aging Deep Space Station (DSS) 70-meter antennas with a new generation of 34-meter antennas. NASA completed the structural development of the pedestal and antenna structure at Canberra in 2013. With the structure complete, NASA will focus on the development and delivery of the electronic systems.

Annual Performance Indicator

FY 2013, FY 2014, and FY 2015 API number and description

Contributing Theme: Space and Flight Support
Contributing Program(s): Space Communications and Navigation

FY 2015 SFS-15-7: Complete the antenna structure at Canberra Deep Space Communications Complex (CDSCC) for Deep Space Station (DSS)-46.

FY 2014 SFS-14-6: Complete the radio frequency equipment installation at Canberra Deep Space Communications Complex (CDSCC) to support operations.

FY 2013 SFS-13-6: Complete antenna structure for DSS-35 at the CDSCC.

API ratings for FY 2013 and past five fiscal years

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	SFS-11-7 Green	SFS-12-7 Green	SFS-13-6 Green

Strategic Goal 1: Expand the frontiers of knowledge, capability, and opportunity in space.

STRATEGIC OBJECTIVE 1.1: EXPAND HUMAN PRESENCE INTO THE SOLAR SYSTEM AND TO THE SURFACE OF MARS TO ADVANCE EXPLORATION, SCIENCE, INNOVATION, BENEFITS TO HUMANITY, AND INTERNATIONAL COLLABORATION.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established next steps for Strategic Objective 1.1, near-term milestones that set the foundation for achievement of this objective. For FY 2014, NASA will:

- Obtain Agency approval to proceed with the Space Launch System (SLS) final design and fabrication;
- Complete the SLS core stage Critical Design Review, giving the project teams permission to begin final design and fabrication of the core stage;
- Complete the Exploration Ground Systems (EGS) Preliminary Design Review (PDR). At PDR, NASA will establish the technical design, cost, and schedule baseline for completing EGS, an effort that will transform Kennedy Space Center's spaceflight facilities into the complex needed to support SLS/Orion missions; and
- Complete Orion manufacturing and assembly so the spacecraft is ready for launch vehicle integration for Exploration Flight Test (EFT)-1 in 2014. EFT-1 will be comprised of an uncrewed Orion flight test vehicle, the launch abort system, service module, spacecraft adaptor and fairings, and Orion-to-stage adaptor. It will launch aboard a Delta IV Heavy rocket, reaching an altitude of 3,600 miles above Earth's surface (much higher than the International Space Station's orbit), orbit approximately twice, and splash down in the Pacific. EFT-1 will test onboard systems and the heat shield and will give the design and operation teams important experience in design, assembly, and preparation for the Orion launch aboard SLS.

Strategic Objective Leader: Greg Williams, Deputy Associate Administrator for Policy and Plans, Human Exploration and Operations Mission Directorate

Multi-year Performance Goal

FY 2015 and FY 2014 1.1.1: Complete critical milestones in the development of the Space Launch System, Orion, and Exploration Ground Systems for the human exploration of deep space. (Agency Priority Goal)

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Exploration Systems Development
Contributing Program(s): Space Launch System

FY 2015 ESD-15-1: Complete the Space Launch System (SLS) Critical Design Review (CDR) in support of Key Decision Point D.

FY 2014 ESD-14-1: Complete the Critical Design Review (CDR) of the Space Launch System (SLS) Core Stage.

FY 2013 ESD-13-1: Complete the SLS Preliminary Design Review (PDR) and establish the technical design, cost, and schedule baseline for the SLS first flight.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	HEC-11-1 Green	ESD-12-1 Green	ESD-13-1 Green

Annual Performance Indicator

Contributing Theme: Exploration Systems Development
Contributing Program(s): Orion Multi-Purpose Crew Vehicle

FY 2015 ESD-15-2: Complete sub-system design reviews for Orion and make progress on system development toward a first uncrewed flight in FY 2018 and first crewed flight in FY 2021-2022.

FY 2014 ESD-14-2: Complete Orion manufacturing and assembly so the spacecraft is ready for launch vehicle integration for the Exploration Flight Test 1 (EFT-1).

FY 2013 ESD-13-2: Manufacture Orion Multi-Purpose Crew Vehicle (MPCV) flight test hardware required for initial integration testing for the Exploration Flight Test 1 (EFT-1).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	HEC-11-2 Green	ESD-12-2 Green	ESD-13-2 Green

Annual Performance Indicator

Contributing Theme: Exploration Systems Development
Contributing Program(s): Exploration Ground Systems

FY 2015 ESD-15-3: Complete the Exploration Ground Systems Program Critical Design Review (CDR).

FY 2014 ESD-14-3: Complete the Exploration Ground Systems Program Preliminary Design Review (PDR).

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 1.1.2: Complete System Requirements Reviews by FY 2015 for the Resource Prospector Mission and In-Situ Resource Utilization Demonstration Experiment on Mars 2020 mission.

FY 2013 1.3.3.1: Prioritize the knowledge of hazards, opportunities, and potential destinations for human space exploration that will be of use to future operations of an integrated architecture for human space exploration.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	1.3.3.1 Green	1.3.3.1 Green

FY 2013 Performance Goal Progress Summary

As part of the effort identified by this performance goal, NASA identified strategic knowledge gaps, or gaps in knowledge or information required to reduce risk, increase effectiveness, and improve the design of robotic and human space exploration missions. NASA uses strategic knowledge gaps to help inform research and investment strategies, and prioritize technology development for human and robotic exploration. In FY 2013, these strategic knowledge gaps were completed, reviewed by the destination-respective Analysis Groups, reviewed by the International Space Exploration Coordination Group, and accepted by other space agencies.

Annual Performance Indicator

Contributing Theme: Exploration Research and Development
Contributing Program(s): Advanced Exploration Systems

FY 2015 ERD-15-1: Complete the System Requirements Review (SRR) for a robotic precursor mission to prospect for lunar ice.

FY 2014 ERD-14-2: Complete International Lander contribution assessments for the robotic precursor mission.

FY 2013 ERD-13-2: Develop a set of strategic knowledge gaps on potential destinations for human spaceflight, facilitate external advisory group review of the gaps and document the results in the Global Exploration Roadmap.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	ERD-12-4 Green	ERD-13-2 Green

Annual Performance Indicator

Contributing Theme: Exploration Research and Development
Contributing Program(s): Advanced Exploration Systems

FY 2015 ERD-15-2: Down-select asteroid capture mechanisms that will be likely candidates for the primary flight system design.

FY 2014 ERD-14-3: Award contracts to industry to fabricate and test several proof of concept asteroid capture mechanisms.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Exploration Research and Development
Contributing Program(s): Advanced Exploration Systems

FY 2015 ERD-15-3: Complete the Systems Requirements Review (SRR) for the In-Situ Resource Utilization Demonstration Experiment on Mars 2020 mission.

FY 2014 ERD-14-6: Define the payload concept for the In-Situ Resource Utilization Demonstration Experiment on Mars 2020 mission.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

Does not trend to FY 2015.

FY 2014 1.1.3: Develop technologies to enable autonomous mission operations in space to increase affordability.

FY 2013 3.3.1.1: Develop technologies to enable autonomous mission operations in space to increase affordability.

Performance Trending:

FY 2011	FY 2012	FY 2013
3.3.1.1 Green	3.3.1.1 Green	3.3.1.1 Green

FY 2013 Performance Goal Progress Summary

NASA continued to make progress toward achieving this performance goal. During FY 2013, NASA demonstrated software and model development for the Exploration Flight Test-1 Advanced Caution and Warning System, as part of the effort to develop tools for increased autonomous operations in space. It completed integrating automation tools with the Total Organic Carbon Analyzer on ISS, which will reduce the crew's dependence on ground-based mission control. Crew training was completed to implement this tool for on-orbit operations.

Test results and analyses from the testing of the Multi-Mission Space Exploration Vehicle (MMSEV) on the air-bearing floor—a large floor at Johnson Space Center that uses a film of air to float objects, like an air hockey table, to simulate microgravity—provided adequate information on the capability needs for a crew excursion vehicle to interact with an asteroid. NASA determined that while anchoring to the asteroid could help in some operations, the maneuverability of the MMSEV around the asteroid and positioning an extravehicular activity crew on a positioning work platform was a better concept.

Annual Performance Indicator

Contributing Theme: Exploration Research and Development
Contributing Program(s): Advanced Exploration Systems

Does not trend to FY 2015.

FY 2014 ERD-14-4: Test Autonomous Mission Operations software for the International Space Station to reduce crew's dependence on ground-based mission control.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

Does not trend to FY 2015.

FY 2014 1.1.4: Mature environmental control and life support system (ECLSS) technology to enable human exploration beyond low Earth orbit.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Exploration Research and Development
Contributing Program(s): Advanced Exploration Systems

Does not trend to FY 2015.

FY 2014 ERD-14-5: Conduct integrated subsystem tests for improved water recovery and more reliable atmosphere revitalization systems.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 1.1.5: Incorporate autonomous controls in life support subsystems testing to increase reliability.

Does not trend to FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Exploration Research and Development
Contributing Program(s): Advanced Exploration Systems

FY 2015 ERD-15-4: Integrate sensors and feedback controls with the air-revitalization subsystem to increase system performance.

Does not trend to FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

STRATEGIC OBJECTIVE 1.2: CONDUCT RESEARCH ON THE INTERNATIONAL SPACE STATION (ISS) TO ENABLE FUTURE SPACE EXPLORATION, FACILITATE A COMMERCIAL SPACE ECONOMY, AND ADVANCE THE FUNDAMENTAL BIOLOGICAL AND PHYSICAL SCIENCES FOR THE BENEFIT OF HUMANITY.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established next steps for Strategic Objective 1.2 that will continue safe space operations and begin building capabilities. For FY 2014, NASA will:

- Maintain a safe and functional on-orbit platform;
- Continue and expand the International Space Station (ISS) on-orbit research program. This includes conducting NASA research, as well as providing the facilities, ISS infrastructure, and ISS crew hours needed to complete on-orbit research;
- Continue the commercial and International Partner cargo missions to resupply the ISS; and
- Continue efforts to extend ISS to at least 2024 to support future human exploration.

Strategic Objective Leader: Greg Williams, Deputy Associate Administrator for Policy and Plans, Human Exploration and Operations Mission Directorate

Multi-year Performance Goal

FY 2015 and FY 2014 1.2.1: Increase utilization of the International Space Station's internal and external research facilities. (Agency Priority Goal)

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2015 ISS-15-1: Continue to increase facility occupancy to 70 percent.

FY 2014 ISS-14-4: Increase facility occupancy beyond the FY 2013 baseline of 60 percent.

FY 2013 ISS-13-4: Fully utilize ISS by ensuring that at least 75 percent of the research sites available are used.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	ISS-13-4 Yellow

Multi-year Performance Goal

FY 2015 and FY 2014 1.2.2: Maintain capability for six on-orbit crew members.

FY 2013 1.1.1.1: Maintain capability for six on-orbit crew members.

Performance Trending:

FY 2011	FY 2012	FY 2013
1.1.1.1 Green	1.1.1.1 Green	1.1.1.1 Green

FY 2013 Performance Goal Progress Summary

During FY 2013, NASA maintained the capabilities to support the six crew members continuously aboard ISS. Crew members representing the United States, Russia, Canada, and Europe rotated every six months on the Russian Soyuz vehicle. All of the required resupply flights, logistics, systems, and operational procedures continued to support a safe and effective ISS platform in space.

Annual Performance Indicator

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2015 ISS-15-2: In concert with International Partners, maintain a continuous six-crew capability on ISS by coordinating and managing resources, logistics, systems, and operational procedures.

FY 2014 ISS-14-1: In concert with International Partners, maintain a continuous six-crew capability on ISS by coordinating and managing resources, logistics, systems, and operational procedures.

FY 2013 ISS-13-1: In concert with International Partners, maintain a continuous six-crew capability on ISS by coordinating and managing resources, logistics, systems, and operational procedures.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ISS06 Green	9ISS6 Green	10ISS07 Green	ISS-11-1 Green	ISS-12-1 Green	ISS-13-1 Green

Multi-year Performance Goal

FY 2015 and FY 2014 1.2.3: Advance engineering, technology, and science research.

FY 2013 1.1.2.1: Maintain a safe and functional ISS national laboratory and utilize it to advance engineering, technology, and science research.

Performance Trending:

FY 2011	FY 2012	FY 2013
1.1.2.1 Green	1.1.2.1 Green	1.1.2.1 Green

FY 2013 Performance Goal Progress Summary

During FY 2013, ISS supported a robust scientific research and technology development program, accomplishing 96 percent of the planned research objectives and providing 100 percent of the planned resources to support research. At the Second Annual ISS Research and Development Conference, held July 16-18, 2013, the American Astronautical Society presented awards to 12 NASA-supported researchers for top discoveries in microgravity science and top applications in medicine, Earth science, materials science, education, and exploration-related technology development.

NASA received a Yellow rating for annual performance indicator ISS-13-4 because only 60 percent of ISS was occupied during FY 2013, missing the target by 15 percent. Internal pressurized sites continually maintained 75 percent occupancy, but the external unpressurized sites were slower to achieve occupancy with the delivery of new Earth and space science payloads. NASA is working to increase occupancy gradually. This will be dependent on continued payload development funding and commercial cargo delivery systems launches. The missed annual performance indicator did not affect NASA's progress toward achieving this performance goal. (Note: As of FY 2014, this API trends to Performance Goal 1.2.1: Increase utilization of the International Space Station's internal and external research facilities.)

Annual Performance Indicator

Contributing Theme: Exploration Research and Development
Contributing Program(s): Human Research

FY 2015 ERD-15-5: Complete ISS one-year mission joint U.S.–Russian research plan and initiate on-orbit research implementation.

FY 2014 ERD-14-1: Complete two space radiation national research campaigns at the NASA Space Radiation Laboratory at Brookhaven National Laboratory.

FY 2013 ERD-13-1: Complete two ISS physiological flight experiments that define requirements for maintaining astronaut health for long-duration missions.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	ERD-11-4 Green	ERD-12-1 Green	ERD-13-1 Green

Annual Performance Indicator

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2015 ISS-15-3: Accomplish a minimum of 90 percent of the on-orbit research and technology development objectives.

FY 2014 ISS-14-3: Accomplish a minimum of 90 percent of the on-orbit research and technology development objectives.

FY 2013 ISS-13-3: Accomplish a minimum of 90 percent of the on-orbit research and technology development objectives. Objectives are baselined by NASA and the ISS Non-profit organization one month prior to each increment, which is the time period between crew rotations.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	ISS-11-5 Green	ISS-12-6 Green	ISS-13-3 Green

Multi-year Performance Goal

FY 2015 and FY 2014 1.2.4: Ensure vital assets are ready, available, and appropriately sized to conduct NASA's Mission.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Space and Flight Support
Contributing Program(s): Human Space Flight Operations

FY 2015 SFS-15-1: Appropriately size the astronaut corps to provide timely assignments based upon mission needs.

FY 2014 SFS-14-7: Appropriately size the astronaut corps to provide timely assignments based upon mission needs.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 1.2.5: Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.

FY 2013 1.1.2.2: Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.

Performance Trending:

FY 2011	FY 2012	FY 2013
1.1.2.2 Green	1.1.2.2 Green	1.1.2.2 Green

FY 2013 Performance Goal Progress Summary

NASA completed all associated annual measures, reflecting NASA's renewed focus on conducting basic scientific research aboard ISS. Payload development to support research in space biology is a high priority, following the guidance of the National Research Council's decadal survey, *Recapturing a Future*

for Space Exploration: Life and Physical Sciences Research for a New Era (prepublication version released April 5, 2011).

Research activity in the physical sciences included the delivery of payloads that represent the continuation of projects now entering a phase of secondary or augmented research goals. In FY 2013, NASA launched four physical sciences payloads to ISS, including the Capillary Flow Experiment-2, InSPACE-3, Advanced Colloids Experiment-1, and the Coarsening in Solid-Liquid Mixtures-3. During the fiscal year, ISS crew members conducted research on six combustion, fluids, or materials science experiments, including the InSPACE-3, Advanced Colloids Experiment-1, Coarsening in Solid-Liquid Mixtures-3, Binary Colloid Alloy Test-5, Constrained Vapor Bubble, and Burning and Suppression of Solids.

Annual Performance Indicator

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2015 ISS-15-4: Carry out the first NASA Research Announcement (NRA)-selected rodent research in the Rodent Research-2 project.

FY 2014 ISS-14-5: Complete all pre-flight activities and be ready to support the launch of the first flight with animals.

FY 2013 ISS-13-6: Conduct flight definition reviews for at least five flight experiments in fundamental space biology that were selected through a NASA Research Announcement.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AC02 Green	9AC3 Green	10AC03 Green	ERD-11-1 Green	ISS-12-7 Green	ISS-13-6 Green

Annual Performance Indicator

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2015 ISS-15-5: Launch three physical science research payloads to ISS; select investigators and conduct the Pre-Ship Review for the Cold Atom Laboratory.

FY 2014 ISS-14-6: Conduct successful Critical Design Reviews (CDR) for four physical science payloads and a Preliminary Design Review (PDR) for the Cold Atom Laboratory in FY 2014.

FY 2013 ISS-13-8: Conduct at least six experiments in combustion, fluids, or materials sciences on ISS.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	9AC2 Green	10AC02 Green	ERD-11-3 Green	ISS-12-9 Green	ISS-13-8 Green

Annual Performance Indicator

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2015 ISS-15-6: CASIS will release two Requests for Proposals, complete proposal evaluation, and select research projects for ISS execution in FY 2015.

FY 2014 ISS-14-7: CASIS will release two Requests for Proposals, complete proposal evaluation, and select research projects for ISS execution in FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2015 ISS-15-7: Produce 500 peer-reviewed publications from projects in human research, space biology, and physical sciences.

FY 2014 ISS-14-8: Produce 450 peer-reviewed publications from projects in human research, space biology, and physical sciences.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

STRATEGIC OBJECTIVE 1.3: FACILITATE AND UTILIZE U.S. COMMERCIAL CAPABILITIES TO DELIVER CARGO AND CREW TO SPACE.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established next steps for Strategic Objective 1.3, near-term milestones that set the foundation for achieving this objective. In FY 2014, NASA will:

- Complete the evaluation of the Commercial Crew Transportation Capability (CCtCap) proposals and begin contract operations while maintaining competition. Industry will continue to mature their commercial crew transportation systems designs and perform some subsystem testing.

Strategic Objective Leader: Phil McAlister, Division Director for Commercial Systems Development Division, Human Exploration and Operations Mission Directorate

Multi-year Performance Goal

FY 2015 and FY 2014 1.3.1: Facilitate the development of and certify U.S. industry-based crew transportation systems while maintaining competition. (Agency Priority Goal)

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Commercial Spaceflight
Contributing Program(s): Commercial Crew

FY 2015 CS-15-1: Continue monitoring partner milestone progress based on Commercial Crew transportation Capability (CCtCap) contract content.

FY 2014 CS-14-1: Complete the Commercial Crew Certification Products Contracts.

FY 2013 CS-13-1: Execute Space Act Agreements (SAAs) for development of a commercial Crew Transportation System (CTS).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8CS08 Yellow	9CS9 Yellow	10CS07 Yellow	CS-11-2 Yellow	None	CS-13-1 Green

Annual Performance Indicator

Contributing Theme: Commercial Spaceflight
Contributing Program(s): Commercial Crew

FY 2015 CS-15-2: Continue monitoring partner milestone progress based on agreement content.

FY 2014 CS-14-2: Award the second phase Commercial Crew Transportation System certification contracts.

Contributing Theme: Commercial Spaceflight
Contributing Program(s): Commercial Cargo

FY 2013: Conduct a minimum of one commercial cargo demonstration flight of new cargo transportation systems, including proximity operations with ISS.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	CS-11-4 Green	CS-12-1 Green	CS-13-2 Green

Multi-year Performance Goal

FY 2015 and FY 2014 1.3.2: Invest financial and technical resources to stimulate efforts within the private sector to develop and demonstrate safe, reliable, and cost-effective space transportation capabilities.

FY 2013 1.2.1.1: Invest financial and technical resources to stimulate efforts within the private sector to develop and demonstrate safe, reliable, and cost-effective space transportation capabilities.

Performance Trending:

FY 2011	FY 2012	FY 2013
1.2.1.1 Green	1.2.1.1 Green	1.2.1.1 Green

FY 2013 Performance Goal Progress Summary

During FY 2013, NASA awarded contracts under the first phase of the certification strategy to three companies. These contracts helped refine the crew transportation system designs (e.g., launch vehicle, spacecraft and ground operations) to meet NASA safety and performance requirements. The first round of deliverables under these contracts was submitted on time to NASA, and NASA reviewed and provided feedback to the companies. NASA also continued to monitor commercial partner technical, programmatic, and financial progress through Commercial Crew Integrated Capability Space Act Agreement milestones. Throughout the year, all partners continued progressing, developing, and demonstrating their integrated commercial crew transportation systems and accomplishing these milestones.

Annual Performance Indicator

Contributing Theme: Commercial Spaceflight
Contributing Program(s): Commercial Crew

Does not trend to FY 2015.

FY 2014 CS-14-4: Conduct Commercial Orbital Transportation Services (COTS) demonstration flight to ISS.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Commercial Spaceflight
Contributing Program(s): Commercial Crew

FY 2015 CS-15-3: Continue monitoring partner milestone progress based on agreement content.

FY 2014 CS-14-5: Complete the evaluation of the Commercial Crew Transportation Capability (CCtCAP) proposals and begin contract operations while maintaining competition.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 1.3.3: Provide cargo transportation to support on-orbit crew members and utilization.

FY 2013 1.1.1.3: Provide cargo and crew transportation to support on-orbit crew members and utilization.

Performance Trending:

FY 2011	FY 2012	FY 2013
1.1.1.3 Green	1.1.1.3 Green	1.1.1.3 Green

FY 2013 Performance Goal Progress Summary

During FY 2013, NASA continued to provide cargo and crew transportation to ISS, fully supporting on-orbit crew operations, through agreements with foreign partners and U.S. commercial providers. These included planned Russian Soyuz and Progress, European Automated Transfer Vehicle, and Japanese H-II Transfer Vehicle flights.

On September 29, 2013, Orbital Sciences Corporation's Cygnus spacecraft berthed with ISS, making its first commercial demonstration cargo delivery, delivering crew supplies and research. Cygnus unberthed from ISS and reentered Earth's atmosphere, where it burned up, in October. In March, SpaceX's Dragon spacecraft made its second successful delivery, taking supplies to ISS and returning scientific research to Earth. The first SpaceX demonstration delivery was conducted in October 2012.

Annual Performance Indicator

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2015 ISS-15-8: Complete at least three flights by U.S.-developed cargo delivery systems, delivering research and logistics hardware to ISS.

FY 2014 ISS-14-2: Complete at least three flights by U.S.-developed cargo delivery systems, delivering research and logistics hardware to ISS.

FY 2013 ISS-13-2: Complete at least three flights, delivering research and logistics hardware to ISS, by U.S.-developed cargo delivery systems.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	ISS-12-3 Green	ISS-13-2 Green

STRATEGIC OBJECTIVE 1.4: UNDERSTAND THE SUN AND ITS INTERACTIONS WITH EARTH AND THE SOLAR SYSTEM, INCLUDING SPACE WEATHER.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established FY 2014 next steps for Strategic Objective 1.4, near-term milestones that set the foundation for achieving this objective.

- Fund operating heliophysics missions in accordance with the 2013 Senior Review results. These are missions that have completed the science set and budget in their original mission plan, but still have operational spacecraft and instruments. NASA reviews the costs of extending operations and the potential additional science return to determine which missions are good candidates for continued operation. Some missions can provide several years, or as in the case of the Voyager spacecraft, decades of additional science data.
- Continue formulation and technology development for Solar Probe Plus (SPP), a mission that will come closer to the Sun than any spacecraft ever flown. SPP will study the streams of charged particles the Sun hurls into space from inside the Sun's corona. SPP entered formulation in January 2012.
- Achieve a successful SPP mission confirmation in 2014. At this point, the Standing Review Board will review the SPP project's overall plans, estimated lifecycle cost and schedule, the science plan, and risk profile to determine if the project is ready to proceed into development.

Strategic Objective Leader: Dr. David Chenette, Director of Heliophysics Division, Science Mission Directorate

Multi-year Performance Goal

FY 2015 and FY 2014 1.4.1: Demonstrate progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.

FY 2013 2.2.1.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.1: "Improve understanding of the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.2.1.1 Green	2.2.1.1 Green	2.2.1.1 Green

FY 2013 Performance Goal Progress Summary

The Heliophysics Subcommittee of the NASA Advisory Committee determined in September 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal.

Voyager Enters Interstellar Space

NASA confirmed that Voyager 1 became the first human-made object to leave the heliosphere, the bubble inflated by the continuous stream of charged particles known as the solar wind. The 36 year-old probe is more than 11 billion miles from the Sun.

Data indicated Voyager 1 had been traveling for about one year through ionized gas, or plasma, present in the space between stars. A coronal mass ejection left the Sun in March 2012 and arrived at Voyager 1, 13 months later in April 2013. The probe recorded vibrations in the surrounding plasma cloud, which allowed scientists to determine the density of the plasma. The data indicated that the probe was immersed in plasma that was 40 times denser than that measured when it was in the outer layer of the heliosphere. Based on this data, they confirmed that Voyager 1 had entered interstellar space on August 25, 2012, when its particle instruments had simultaneously recorded the highest rate of cosmic rays, charged particles from outside the heliosphere, and the disappearance of charged particles from inside the heliosphere. Visit the Interstellar Voyager page for more information.

IBEX Shows Shifting Cosmic Winds

Scientists discovered that the particles streaming into the solar system from interstellar space have likely changed direction over the last 40 years. The Interstellar Boundary Explorer (IBEX) measured faint signals in the form of energetic neutral atoms from the trailing edge of the heliosphere. These observations enabled the scientists to determine the direction and shape of the tail of the heliosphere. This "heliotail" is much flatter and larger than expected and is deflected by the interstellar magnetic field surrounding the Sun's heliosphere. Combining observations from IBEX, Ulysses, the Advanced Composition Explorer (ACE), and the Solar Terrestrial Relations Observatory (STEREO), with 40 years of historical databases, scientists discovered that the interstellar gas breezing through the solar system has shifted in direction by six degrees. This shows that the Sun and the solar system live in a surprisingly complex and dynamic part of the Milky Way galactic environment that evolves on much shorter timescales than previously believed. Read more about this finding.

Images Reveal Magnetic Braids

The Sun's visible surface is hot, but the outer atmosphere of ionized gas, or corona, is far hotter. In FY 2013, scientists reported data showing that there are at least two heating mechanisms that make the corona so hot. During quiet solar periods, when there are fewer solar flares and coronal mass ejections, wave heating may be the prevalent mechanism, heating the corona to 2-3.6 million °F. Alfvén waves grow and travel along the magnetic field lines that emerge from the Sun's surface. As the magnetic field lines force charged particles, or plasma, along their length, the Alfvén waves transfer huge amounts of energy from the solar interior through the solar surface and release it in the corona. However, the active corona needs additional heating to reach even hotter temperatures. Observations made by an instrument launched aboard a NASA sounding rocket in July 2012 found the potential source for these hotter temperatures come from the reconnection and unraveling of magnetic "braids." Magnetic reconnection happens when magnetic field lines come together, break apart, and then exchange partners, snapping into

new positions and releasing a jolt of magnetic energy. The instrument's high-resolution images allowed scientists for the first time to observe directly magnetic reconnection in the chromosphere, showing magnetic braids in a coronal active region that were reconnecting, relaxing, and releasing enough energy to heat the structures to about seven million °F.

Annual Performance Indicator

Contributing Theme: Heliophysics
Contributing Program(s): Multiple Programs

FY 2015 HE-15-1: Demonstrate planned progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.

FY 2014 HE-14-1: Demonstrate planned progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.

FY 2013 HE-13-1: Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8HE01 Green	9HE1 Green	10HE01 Green	HE-11-1 Green	HE-12-1 Green	HE-13-1 Green

Annual Performance Indicator

Contributing Theme: Heliophysics
Contributing Program(s): Living with a Star

Does not trend to FY 2015.

FY 2014 HE-14-2: Complete mission success criteria for the Van Allen Probes mission.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 1.4.2: Demonstrate progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system.

FY 2013 2.2.2.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.2: "Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.2.2.1 Green	2.2.2.1 Green	2.2.2.1 Green

FY 2013 Performance Goal Progress Summary

The Heliophysics Subcommittee of the NASA Advisory Committee determined in September 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

New Radiation Belt Hazards Discovered by the Van Allen Probes and the Heliophysics System Observatory

New observations made by the Van Allen Probes revealed a third distinct radiation belt around Earth. The Van Allen radiation belts are comprised of high-energy electrons and protons trapped by Earth's magnetic field, which are dangerous to both satellites and crewed spaceflight. Previous studies have long documented two distinct regions, or belts, of trapped radiation. This new belt is created during solar and geomagnetic disturbances and decays in about a month. Analysis of data from the Geotail and the Time History of Events and Macroscale Interactions during Substorms (THEMIS) satellites further showed where and when the radiation belts become energized by common geomagnetic storms and why they are generally structured into two belts. These new discoveries are important for improving scientists' understanding of how the radiation belts respond to solar variations and for improving the ability to predict their behaviors to protect space technologies.

Space Traffic May Increase Polar Mesospheric Clouds

A study released during FY 2013 using the Aeronomy of Ice in the Mesosphere (AIM) satellite data suggests that increases in polar mesospheric clouds could be due to increases in space traffic. Polar mesospheric clouds are the highest layer of clouds in Earth's atmosphere, forming near the north and south poles at altitudes of about 84 kilometers. They are sometimes compared to the miner's canary for climate change in Earth's upper atmosphere, providing early warning of potentially undesirable changes. The recent increase in the amount of space traffic in 2011 and 2012 (the study covered data from 2007 to 2012) coincides with the unusual increase in polar mesospheric clouds. The estimate of the amount of water released during space launches is consistent with the hypothesis that the increase in these clouds is due to space traffic.

Slow Solar Storm Onsets Buffer Satellites from Solar Storm Effects

Using data from the Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics (TIMED) and the Challenging Mini-Satellite Payload for Geo-scientific Research and Applications (CHAMP) satellites, researchers discovered that solar wind density enhancements and pressure pulses prior to a geomagnetic storm can trigger processes that unexpectedly reduce the impact of the storm on satellites. Geomagnetic storms heat and drive an expansion of Earth's thermosphere, resulting in increased satellite drag and unexpected shifting of their orbits. Strong precursors to a storm turn up Earth's thermostat, through pre-production of nitric oxide, which effectively radiates the excess energy of the geomagnetic storm back into space. These strong precursors are rare and explain why certain geomagnetic storms have virtually no effect on satellite orbits while other storms that are essentially identical have great effect.

Annual Performance Indicator

Contributing Theme: Heliophysics
Contributing Program(s): Multiple Programs

FY 2015 HE-15-2: Demonstrate planned progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system.

FY 2014 HE-14-4: Demonstrate planned progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system.

FY 2013 HE-13-4: Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8HE03 Green	9HE6 Green	10HE06 Green	HE-11-4 Green	HE-12-4 Green	HE-13-4 Green

Multi-year Performance Goal

FY 2015 and FY 2014 1.4.3: Demonstrate progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.

FY 2013 2.2.3.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.3: "Maximize the safety and productivity of

human and robotic explorers by developing the capability to predict extreme and dynamic conditions in space.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.2.3.1 Green	2.2.3.1 Green	2.2.3.1 Green

FY 2013 Performance Goal Progress Summary

The Heliophysics Subcommittee of the NASA Advisory Committee determined in September 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

Characterizing the Moon's Radiation Environment

Findings published in FY 2013 from data collected by the Lunar Reconnaissance Orbiter (LRO) may help future space explorers. The radiation environment near the Moon could be damaging to humans and electronics on future missions. To characterize this potentially hazardous environment, the Cosmic Ray Telescope for the Effects of Radiation (CRaTER) instrument on board LRO measures the radiation that would be absorbed by either electronic parts or human tissue behind the shielding of a spacecraft. CRaTER has measured the lunar radiation environment since 2009, during the recent solar minimum. The solar wind is less turbulent during solar minima and presents less of a barrier to incoming galactic cosmic rays, particles generated by supernova explosions and other high-energy events outside the solar system. Therefore, galactic cosmic rays were at a high during that time period. From the observations, scientists were able to derive energy spectra for the radiation dose that humans or instruments would absorb in the lunar environment. Read more about these findings.

Data from MSL Aids Human Exploration Planning

Two forms of radiation pose health risks to astronauts in deep space: galactic cosmic rays and solar energetic particles, associated with solar flares and coronal mass ejections from the Sun. During FY 2013, scientists reported that the heliophysics-technology based instrument, the Radiation Assessment Detector (RAD), onboard the Mars Science Laboratory's (MSL's) Curiosity rover provided the first-ever direct measurements of the galactic cosmic ray and solar energetic particle radiation that astronauts will encounter as they venture beyond Earth's protective magnetic field and embark on a journey to Mars. These measurements, taken on MSL's transit to Mars during 2012, showed that during a 360-day round trip, an astronaut would receive a dose of about 662 millisieverts (mSv), a measure of radiation dose used to assess lifetime cancer risk. Based on MSL's data, an astronaut on a round-trip to Mars would have been exposed to a considerable amount of radiation when compared with a usual career exposure limit of 1,000 mSv or less. The current solar activity cycle is the weakest of the Space Age. In the future, the Sun is likely to unleash more powerful flares and coronal mass ejections more frequently, causing astronauts to reach their exposure limits during part of their long journey on a mission to Mars.

An Extreme Solar Event

On July 23, 2012, a massive cloud of solar material erupted off an active region of the Sun that space scientists had been monitoring, creating what is known as a coronal mass ejection. Fortunately for this technological society, the cloud raced in a direction mostly away from Earth, but luckily passed one of NASA's Solar Terrestrial Relations Observatory (STEREO) spacecraft along the way. The coronal mass ejection was traveling at speeds between 1,800 and 2,200 miles per second. The coronal mass ejection was accompanied by an unusually intense solar energetic particle event, which could have caused a geomagnetic storm affecting satellite operations and, potentially, power grids if it had directly impacted Earth. Instead Earth was near the edge of the solar energetic particle cloud and experienced a modest solar energetic particle storm. This event shows that the Sun can produce extreme events even during a relatively modest solar cycle and improves scientists' estimates of the probability of such extreme events occurring. Read more about this event.

Annual Performance Indicator

Contributing Theme: Heliophysics
Contributing Program(s): Multiple Programs

FY 2015 HE-15-3: Demonstrate planned progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.

FY 2014 HE-14-7: Demonstrate planned progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.

FY 2013 HE-13-5: Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8HE05 Green	9HE8 Green	10HE08 Green	HE-11-5 Green	HE-12-5 Green	HE-13-5 Green

Multi-year Performance Goal

FY 2015 and FY 2014 1.4.4: By December 2017, launch two missions in support of Strategic Objective 1.4.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Heliophysics
Contributing Program(s): Solar Terrestrial Probes

FY 2015 HE-15-4: Launch the Magnetospheric MultiScale (MMS) mission.

FY 2014 HE-14-3: Complete Magnetospheric MultiScale (MMS) Observatory #4 Environmental Test.

FY 2013 HE-13-3: Complete integration of the payload to the Magnetospheric Multiscale (MMS) satellite #1 (of four).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8HE02 Green	9HE2 Green	10HE02 Green	HE-11-2 Green	HE-12-2 Green	HE-13-3 Green

Annual Performance Indicator

Contributing Theme: Heliophysics
Contributing Program(s): Living with a Star

FY 2015 HE-15-5: Initiate Solar Orbiter Collaboration launch integration activities at Kennedy Space Center.

FY 2014 HE-14-5: Complete Solar Orbiter Collaboration Heavy Ion Sensor (HIS) Instrument Critical Design Review (CDR).

FY 2013 HE-13-6: Complete the Solar Orbiter Collaboration Mission Confirmation Review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	HE-13-6 Green

Annual Performance Indicator

Contributing Theme: Heliophysics
Contributing Program(s): Living with a Star

FY 2015 HE-15-6: Complete Solar Probe Plus (SPP) Critical Design Review (CDR).

FY 2014 HE-14-6: Complete Solar Probe Plus (SPP) Preliminary Design Review (PDR).

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10HE04 Green	None	None	None

STRATEGIC OBJECTIVE 1.5: ASCERTAIN THE CONTENT, ORIGIN, AND EVOLUTION OF THE SOLAR SYSTEM AND THE POTENTIAL FOR LIFE ELSEWHERE.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established FY 2014 next steps for Strategic Objective 1.5, near-term milestones that set the foundation for achieving this objective.

- Execute restructuring of the Planetary Science Research and Analysis Program in the Research Opportunities in Space and Earth Sciences (ROSES)–2014 solicitation, ensuring alignment between the research programs and the annual performance indicators in NASA's FY 2014 and FY 2015 Performance Plans. Visit NASA's Grant Solicitations page for more on ROSES.
- Strengthen the cross-divisional collaboration between Planetary Science and Astrophysics to conduct an exoplanets research program, focusing resources on this rapidly emerging field of study.
- Continue implementation of the New Frontiers Program mission, the Origins Spectral Interpretation Resource Identification Security–Regolith Explorer (OSIRIS-REx), and the Discovery Program mission, the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSIGHT). In April 2013, OSIRIS-REx entered the development phase, when the elements of a spacecraft are built, assembled, and tested in preparation for launch. InSIGHT is in the formulation phase, when the mission's requirements are set.
- Solicit and select instruments for a Mars 2020 rover mission. Mars 2020 will continue to assess Mars as a potential habitat for life, search for signs of past life, and collect samples for possible future return to Earth. It also will be a technology demonstration for future human exploration of Mars. NASA announced the solicitation on September 24, 2013.

Strategic Objective Leader: Dr. James Green, Director of Planetary Science Division, Science Mission Directorate

Multi-year Performance Goal

FY 2015 and FY 2014 1.5.1: Demonstrate progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact and evolve.

FY 2013 2.3.1.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.1: "Inventory solar system objects and identify the processes active in and among them.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.3.1.1 Green	2.3.1.1 Green	2.3.1.1 Green

FY 2013 Performance Goal Progress Summary

The Planetary Science Subcommittee of the NASA Advisory Committee determined in November 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

Cassini Finds Tidal Forces Controlling Enceladus' Jets

Enceladus' geological activity varies systematically as the moon moves around its elliptical orbit, suggesting the icy fractures and resulting jets are powered by Saturn's gravitational pull. This discovery, announced in July 2013, was based on observations made by the Cassini spacecraft. When Enceladus is farther from Saturn, fissures are pulled open and approximately four times more material escapes from the moon's jets than when Enceladus is closer to Saturn. This discovery began as a mathematical simulation of the jets, and was then confirmed through analysis of 252 images captured by the Cassini spacecraft. Read more about this discovery.

Wild Weather on Saturn's Moon Titan

Wind-whipped waves and cyclones could occur on Saturn's moon Titan as summer arrives in the north. Cassini observations of waves, or the absence of waves, during this time have provided valuable clues about the global climate of Titan.

Some of Titan's hydrocarbon lakes and seas are as large as the Great Lakes or Caspian Sea. However, Titan has a denser atmosphere than Earth's and less gravity. Its lakes and seas of ethane and methane have a lower surface tension than the equivalent bodies of liquid on Earth. These and other factors mean that even a light wind of one mile an hour could potentially whip up waves. Winds are predicted to exceed the threshold for generating detectable waves as Titan approaches summer solstice in 2017. Even tropical cyclones could also conceivably occur over Titan's polar hydrocarbon seas as summer warms the northern hemisphere. Read more about this finding.

Water Ice and Organics Near Mercury's North Pole

Observations released during FY 2013 by the Neutron Spectrometer on the Mercury Surface, Space Environment, Geochemistry, and Ranging (MESSENGER) spacecraft indicate that Mercury's permanently shadowed polar craters harbor abundant water ice and other frozen volatile, or easily evaporated, water-rich material. The presence of water ice on the innermost planet is surprising given its proximity to the Sun. However, the tilt of Mercury's rotational axis is almost zero—less than one degree—so there are pockets at the planet's poles that never see sunlight.

Measurements made by MESSENGER's Mercury Laser Altimeter (MLA) near the planet's north pole revealed anomalously dark and bright regions. The MLA measures average hydrogen concentrations in these radar bright polar regions, which allows scientists to determine water-ice concentrations. The data indicated that Mercury's polar deposits contain, on average, a hydrogen-rich layer more than tens of centimeters thick beneath a surficial layer 10 to 20 centimeters thick that is less rich in hydrogen. The optically bright regions are consistent with the presence of surficial water ice, whereas MLA dark regions have temperature structures consistent with buried water ice covered by an insulating surface layer of another volatile material, most likely complex organic deposits. Impacts onto Mercury of comets or

volatile-rich asteroids could have provided both the water ice and dark, organic-rich material. Read more about this finding.

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Multiple Programs

FY 2015 PS-15-1: Demonstrate planned progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact and evolve.

FY 2014 PS-14-1: Demonstrate planned progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact and evolve.

FY 2013 PS-13-1: Demonstrate planned progress in inventorying solar system objects and identifying the processes active in and among them. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	PS-11-1 Green	PS-12-1 Green	PS-13-1 Green

Multi-year Performance Goal

FY 2015 and FY 2014 1.5.2: Demonstrate progress in exploring and observing the objects in the solar system to understand how they formed and evolve.

FY 2013 2.3.2.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.2: "Improve understanding of how the Sun's family of planets, satellites, and minor bodies originated and evolved.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.3.2.1 Green	2.3.2.1 Green	2.3.2.1 Green

FY 2013 Performance Goal Progress Summary

The Planetary Science Subcommittee of the NASA Advisory Committee determined in November 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

GRAIL Reveals the Moon's Interior Structure

The Moon is a key to deciphering the evolutionary history of the terrestrial planets because it is the most accessible planetary body that preserves a surface record spanning most of solar system history. Reconstructing the evolution of a planet requires an understanding of the structure of its interior. In December 2012, scientists reported that they had used observations from the Gravity Recovery and Interior Laboratory (GRAIL) to construct a detailed gravitational field map of the Moon. The GRAIL field map revealed never-before-seen tectonic structures, volcanic landforms, basin rings, crater central peaks, and numerous simple craters. It also identified a population of linear gravity anomalies, with lengths of hundreds of kilometers, crisscrossing the surface. These linear anomalies appear to be "dikes," or long, thin, vertical bodies of solidified magma in the subsurface. The dikes, which are among the oldest lunar features, will provide insight into the Moon's early history. The distribution, orientation, and dimensions of the dikes suggest that the Moon's radius increased by 0.4 to 3 miles early in lunar history, consistent with scientists' predictions. Read more about the map created by the GRAIL mission.

Abundance of Volatiles on Vesta

Multiple observations obtained by instruments onboard the Dawn spacecraft revealed a significant amount of volatile, or easily evaporated, water-rich material, on the surface of the asteroid Vesta. The observations show an unusual pitted terrain that likely formed when the volatiles boiled off from heating by impacting. Other asteroids crashed into Vesta, and the heat from the collisions converted the hydrogen bound to the minerals into water, which evaporated, leaving pothole-like features. Scientists believe that the volatiles were deposited by a carbon-rich impactor, which struck Vesta at low velocity. This discovery is important because it strengthens the long-held idea that primitive bodies are the source of carbon and volatiles in the early solar system. Read more about these findings.

Mars Climate Evolution

Papers released in FY 2013 reported measurements of the Martian atmosphere's composition by NASA's Curiosity rover, providing evidence about loss of much of Mars' original atmosphere. Analytic laboratories onboard Curiosity have added to the evidence that Mars once had a much thicker atmosphere, essential to having persistent water on the planet's surface long ago. Curiosity checked ratios of heavier to lighter isotopes of carbon and oxygen in the carbon dioxide that makes up most of the planet's atmosphere. Heavy isotopes of carbon and oxygen are enriched in today's thin Martian atmosphere compared with the proportions in the raw material that formed Mars, as deduced from proportions in the Sun and other parts of the solar system. The enrichment of heavier isotopes measured in the dominant carbon-dioxide gas points to a process of loss from the top of the atmosphere, favoring loss of lighter isotopes, rather than a process of the lower atmosphere interacting with the ground. These findings also confirm the origin of several Mars meteorites found on Earth. Gas bubbles in those meteorites have the same isotopic signature as Curiosity measured on Mars. Read more about these findings.

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Multiple Programs

FY 2015 PS-15-2: Demonstrate planned progress in exploring and observing the objects in the solar system to understand how they formed and evolve.

FY 2014 PS-14-4: Demonstrate planned progress in exploring and observing the objects in the solar system to understand how they formed and evolve.

FY 2013 PS-13-3: Demonstrate planned progress in understanding how the Sun's family of planets, satellites, and minor bodies originated and evolved. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8PS01 Green	9PS1 Green	10PS01 Green	PS-11-4 Green	PS-12-4 Green	PS-13-3 Green

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Multi-year Performance Goal

FY 2015 and FY 2014 1.5.3: Demonstrate progress in exploring and finding locations where life could have existed or could exist today.

FY 2013 2.3.3.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.3: "Improve understanding of the processes that determine the history and future of habitability of environments on Mars and other solar system bodies.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.3.3.1 Green	2.3.3.1 Green	2.3.3.1 Green

FY 2013 Performance Goal Progress Summary

The Planetary Science Subcommittee of the NASA Advisory Committee determined in November 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal.

Water in an Old Martian Meteorite

Researchers have determined that the meteorite NWA 7034 formed 2.1 billion years ago during the beginning of the Amazonian period on Mars. This is the only dated Martian meteorite from this period; the rest range in age from about 200 million to 1.3 billion years (except the ancient ALH84001). The meteorite NWA 7034 has an order of magnitude more water compared with other, younger, Martian meteorites. Although there were likely still minor releases of water on the surface during the Amazonian, this process was likely insignificant compared to the extensive erosion caused by water earlier in Martian history. The meteorite also has a different mixture of oxygen isotopes than has been found in other Martian meteorites, which could have resulted from interaction with the Martian atmosphere. Other than the amount of water found in the meteorite, its unusual chemistry matches that of the Martian crust as measured by NASA's Mars Exploration Rovers and Mars Odyssey and will be an important piece of physical evidence that should help researchers interpret new data to be returned by the Mars Curiosity rover.

Microbes Survive a Mixed Bag of Mars 'Biocidals'

The low pressure, freezing temperatures, and oxygen-starved conditions on Mars were long considered to be deadly for microbes from Earth. Astrobiologists have found that microbes can survive and even grow under these conditions. Microbes from permafrost soil (genus Carnobacterium) collected in northeastern Siberia were found to grow at pressures of as low as seven millibars, the global average surface pressure of Mars. In a companion study, 26 strains of bacteria commonly found on spacecraft were incubated under the same Mars-like conditions, and investigations showed that one bacterium, Serratia liquefaciens, was able to survive and grow. Read more about these findings.

Curiosity Finds a Once-Habitable Environment on Mars

Analyses of rock samples collected during Curiosity's first drilling campaign showed that ancient Mars could have supported living microbes. Scientists identified sulfur, nitrogen, hydrogen, oxygen, phosphorus, and carbon—the key chemical ingredients for life—in the powder Curiosity drilled out of a sedimentary rock near an ancient stream bed in Gale Crater. The data indicate that the Yellowknife Bay area the rover was exploring is the end of an ancient river system or an intermittently wet lake bed that could have provided chemical energy and other favorable conditions for microbes. The rock is made up of a fine-grained mudstone containing clay minerals, sulfate minerals, and other chemicals. This ancient wet environment, unlike some others on Mars, was not harshly oxidizing, acidic, or extremely salty. Scientists were surprised to find a mixture of oxidized, less-oxidized, and even non-oxidized chemicals close to the surface, providing an energy gradient of the sort many microbes on Earth exploit to live. Read more about these analyses.

Mapping the Chemistry for Life on Europa

A study led by a NASA researcher showed that hydrogen peroxide is abundant on the surface of Jupiter's moon Europa. As the peroxide on Europa's surface mixes into the ocean below, it could provide an energy supply for potential life forms. This is based on studies of ancient Earth that show that oxidant availability, like peroxide, played an important role in the evolution of complex multicellular life. For this to be the case, the hydrogen peroxide would have to be able to travel through the moon's icy shell and into the subsurface ocean. However, previous studies indicated that mixing does occur in Europa's ice

layer, making it likely that hydrogen peroxide could reach the liquid water ocean. Read more about this study.

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Multiple Programs

FY 2015 PS-15-3: Demonstrate planned progress in exploring and finding locations where life could have existed or could exist today.

FY 2014 PS-14-5: Demonstrate planned progress in exploring and finding locations where life could have existed or could exist today.

FY 2013 PS-13-6: Demonstrate planned progress in understanding the processes that determine the history and future of habitability of environments on Mars and other solar system bodies. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8PS06 Green	9PS8 Green	10PS09 Green	PS-11-8 Green	PS-12-7 Green	PS-13-6 Green

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Mars Exploration

Does not trend to FY 2015.

FY 2014 PS-14-6: Complete mission success criteria for Mars Science Laboratory (MSL).

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8PS05 Green	9PS4 Red	10PS06 Yellow	PS-11-9 Green	PS-12-8 Green	None

Multi-year Performance Goal

FY 2015 and FY 2014 1.5.4: Demonstrate progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.

FY 2013 2.3.4.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.4: "Improve understanding of the origin and evolution of Earth's life and biosphere to determine if there is or ever has been life elsewhere in the universe.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.3.4.1 Green	2.3.4.1 Green	2.3.4.1 Green

FY 2013 Performance Goal Progress Summary

The Planetary Science Subcommittee of the NASA Advisory Committee determined in November 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal.

A Slow Start for Complex Life on Ancient Earth

Scientists filled in a billion-year gap in knowledge between 1.8 and 0.8 billion years ago about Earth's early ocean. This was a critical time in the evolution of eukaryotes (single and multi-cell organisms more complex than prokaryotes like bacteria), but has been deemed the "boring billion" because biological and environmental conditions remained relatively static and the oceans contained mostly bacteria. By examining the geological remains of ancient ocean sediments and, in particular, the elements molybdenum and chromium, which are very sensitive to oxygen concentrations, scientists have learned how these static conditions were possible.

Could Life Exist Around Hydrothermal Vents on Europa?

Astrobiologists provided new evidence that life may have originated in alkaline environments around submarine hydrothermal vents in Earth's ancient ocean. The study focused on whether metal-containing enzymes came before or after enzymes containing the organic compounds necessary for biological activity. An analysis of the genes for these enzymes shows that metal-containing enzymes were present in the organism that is at the root of the tree of life, or the Last Universal Common Ancestor of life on Earth. The study shows that the metal precipitates (insoluble compounds that emerge from a liquid solution) present in ancient hydrothermal vents could be the original building blocks of the active centers of ancient proto-enzymes. Since hydrothermal vents might also exist in oceans on other worlds, such as Jupiter's moon Europa, studying their role in the origin of life on Earth may help determine the potential for life elsewhere in the solar system and beyond.

Microbes Buried Below Ocean Ridges

Scientists supported in part by the NASA Astrobiology Institute provided new information about microbial communities below the ocean floor on the flanks of mid-ocean ridges. The team drilled into 3.5

million year-old basalt near the Juan de Fuca Ridge off the coast of Washington state. In the samples they collected, they discovered clear signs of an active microbial ecosystem. Studying how life survives in such subsurface environments can provide important insights into life's ability to adapt to harsh conditions. This information is essential for determining the potential for life on other worlds in the solar system, such as Jupiter's moon Europa.

Ancient Microfossils Appear to Include Plankton

Carbon isotopic analyses imply that three billion year-old spindle-shaped structures are microfossils of plankton that inhabited the early oceans. The research team, which included members from Pennsylvania State University, Johnson Space Center, and Nagoya University, not only showed that these inclusions in the rocks were biological in origin, but also that they were likely planktonic autotrophs, tiny organisms that lived in the sea that produced their own food through photosynthesis.

Life at the Fringes of Habitable Environments

Atmospheric winds can transport microorganisms over great distances, even across oceans. A study released in December 2012 showed a surprising richness of diversity (over 2,100 unique species) of microorganisms are hitching rides in the upper troposphere of Earth, and that some of these microorganisms have even adapted to traveling long distances at high altitude. Astrobiologists gathered DNA from the atmosphere from two large dust plumes that came across the Pacific from Asia to North America in spring 2011. This study provides insight into one of the last biological ecosystems on Earth to be explored, showing how life can survive in environments at the fringes of what is considered habitable.

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Multiple Programs

FY 2015 PS-15-4: Demonstrate planned progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.

FY 2014 PS-14-8: Demonstrate planned progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.

FY 2013 PS-13-8: Demonstrate planned progress in understanding the origin and evolution of life on Earth and throughout the biosphere to determine if there is or ever has been life elsewhere in the universe. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8PS04 Green	9PS5 Green	10PS07 Green	PS-11-11 Green	PS-12-11 Green	PS-13-8 Green

Multi-year Performance Goal

FY 2015 and FY 2014 1.5.5: Demonstrate progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.

FY 2013 2.3.5.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.3.5: "Identify and characterize small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.3.5.1 Green	2.3.5.1 Green	2.3.5.1 Green

FY 2013 Performance Goal Progress Summary

The Planetary Science Subcommittee of the NASA Advisory Committee determined in November 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

NASA Near Earth Asteroid Survey

NASA and its partners maintain a watch for near-Earth objects (NEOs), asteroids, and comets that pass close to Earth as part of an ongoing effort to discover, catalog, and characterize these potentially hazardous objects. The total number of discovered NEOs surpassed 10,000 in June 2013. During FY 2013, asteroid search teams funded by NASA's Near Earth Object Observation (NEOO) Program found another 11 asteroids larger than one kilometer in size with orbits coming within Earth's vicinity. Asteroid search teams also found two more near-Earth comets and 949 smaller asteroids of less than one kilometer in average size, bringing the total number known of all sizes to 10,163. The high-precision orbit predictions computed by NASA's Jet Propulsion Laboratory show that none of these objects is likely to hit Earth in the next century. However, 1,425 small bodies (of which 154 are larger than one kilometer in diameter) are in orbits that could become a hazard in the more distant future and warrant continued monitoring.

Asteroid Close Encounters

- A small asteroid with the provisional designation 2012 DA14 skirted past Earth on February 15, 2013. The La Sagra Sky Survey discovered the asteroid, which was about 45 meters in diameter, a year earlier near Mallorca, Spain. At closest approach, 2012 DA14 passed within 27,800 kilometers of Earth's surface, below the communications and weather satellites in geosynchronous orbit around Earth. A few days later, NASA's Deep Space Network planetary radar showed the object to have an approximately 20 by 40 meter oblong shape, with a rotational period of about eight hours.

- Around the same time, another small asteroid (about 17 to 20 meters across) impacted Earth near Chelyabinsk, Russia. This superbolide, or supermeteor, released roughly the equivalent of 500 to 550 kilotons of TNT. The Chelyabinsk event was the most energetic impact event since the large explosion caused by an asteroid impact near the Podkamennaya Tunguska River in Russia in 1908. Within weeks of the impact in Western Siberia, the NEOO Program obtained samples for further analysis. These pieces of the Chelyabinsk fall are at Johnson Space Center's astromaterials laboratory undergoing further examination.

International and Interagency Activities

During FY 2013 the NEOO Program supported:

- An Earth impact tabletop exercise, conducted by the Federal Emergency Management Agency (FEMA) Headquarters in Washington, DC. The exercise's primary goal was to acquaint FEMA with the nature of an asteroid or comet and how a warning of an impact might evolve if the threatening object was detected a short time prior to possible impact.
- The 56th United Nations Committee on the Peaceful Uses of Outer Space in Vienna, Austria. The NEO subcommittee, in its 50th session, endorsed the Working Group report on NEOs, including the recommendations on the international response to the NEO impact threat.
- The third Planetary Defense Conference (PDC) as one of 12 co-sponsors for PDC, held in April 2013 in Flagstaff, AZ, had more than 200 participants from more than 20 countries. PDC is an opportunity for members of the NEO research community to study the impact threat NEOs pose for Earth.

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Multiple Programs

FY 2015 PS-15-5: Conduct research into mitigation strategies utilizing observed characteristics and properties of those small bodies that pose a threat to terrestrial life.

FY 2014 PS-14-10: Conduct research into mitigation strategies utilizing observed characteristics and properties of those small bodies that pose a threat to terrestrial life.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Multiple Programs

FY 2015 PS-15-9: Demonstrate planned progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.

FY 2014 PS-14-12: Demonstrate planned progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 1.5.6: By December 2017, launch at least two missions in support of Strategic Objective 1.5.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): New Frontiers

FY 2015 PS-15-6: Complete the Origins Spectral Interpretation Resource Identification Security–Regolith Explorer (OSIRIS-REx) Systems Integration Review (SIR).

FY 2014 PS-14-2: Complete the Origins Spectral Interpretation Resource Identification Security–Regolith Explorer (OSIRIS-REx) Critical Design Review (CDR).

FY 2013 PS-13-5: Complete the OSIRIS-REx Preliminary Design Review (PDR).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10PS04 Green	PS-11-3 Green	PS-12-2 Yellow	PS-13-5 Green

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Discovery

FY 2015 PS-15-7: Complete the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSIGHT) Systems Integration Review (SIR).

FY 2014 PS-14-3: Complete the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSIGHT) mission (Discovery 12) Critical Design Review (CDR).

FY 2013 PS-13-2: Initiate the preliminary design for the Discovery 12 mission.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	PS-12-3 Green	PS-13-2 Green

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Mars Exploration

Does not trend to FY 2015.

FY 2014 PS-14-7: Launch the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) mission.

FY 2013 PS-13-7: Complete the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) Pre-Ship Review (PSR).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10PS08 Green	PS-11-10 Green	PS-12-9 Green	PS-13-7 Green

Annual Performance Indicator

Contributing Theme: Planetary Science
Contributing Program(s): Mars Exploration

FY 2015 PS-15-8: Complete the Mars 2020 Preliminary Design Review (PDR).

Does not trend to FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

STRATEGIC OBJECTIVE 1.6: DISCOVER HOW THE UNIVERSE WORKS, EXPLORE HOW IT BEGAN AND EVOLVED, AND SEARCH FOR LIFE ON PLANETS AROUND OTHER STARS.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established FY 2014 next steps for Strategic Objective 1.6, near-term milestones that set the foundation for achieving this objective.

- Conduct Senior Review for operating missions. During this biennial review, NASA assesses the costs of extending operations and the potential additional science return to determine which missions are good candidates for continued operation.
- Participate in the European Space Agency's mission concept study for their second large mission in the Cosmic Vision Programme, with the intent to establish a partnership on the mission.
- Plan for the Explorers Announcement of Opportunity. Astrophysics Explorers are Principal Investigator-led small- and medium-class missions with focused scientific investigations.
- Strengthen the cross-divisional collaboration between Astrophysics and Planetary Science to conduct an exoplanets research program, focusing resources on this rapidly emerging field of study.
- Complete the James Webb Space Telescope (JWST) spacecraft Critical Design Review (CDR). After completing CDR, the project will proceed with final design and fabrication of JWST.
- Complete the Key Decision Point (KDP)-C review for the Neutron star Interior Composition Explorer (NICER). At KDP-C, the Standing Review Board will determine if the project has adequately set the requirements, with acceptable risk and estimated lifecycle cost and schedule baseline, and has set a project and science plan.
- Complete the System Requirements Review (SRR) for the Transiting Exoplanet Survey Satellite (TESS).
- Complete KDP-E for the Stratospheric Observatory for Infrared Astronomy (SOFIA). This review follows achievement of Full Operational Capability, and signals completion of implementation.
- Deliver the Soft X-ray Spectrometer, NASA's contribution to the Astro-H mission, to the Japan Aerospace Exploration Agency (JAXA). Astro-H is being built by JAXA for the study of extremely energetic processes in the universe.
- Complete KDP-D for the International Space Station instrument Cosmic Ray Energetics and Mass, or ISS-CREAM. At KDP-D, the NASA will determine if the ISS-CREAM project has adequately completed the build phase and is ready to go into testing.

Strategic Objective Leader: Dr. Paul Hertz, Director of Astrophysics Division, Science Mission Directorate

Multi-year Performance Goal

FY 2015 and FY 2014 1.6.1: Launch the James Webb Space Telescope. (Agency Priority Goal)

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: James Webb Space Telescope
Contributing Program(s): James Webb Space Telescope

FY 2015 JWST-15-1: Deliver JWST flight backplane to Goddard Space Flight Center.

FY 2014 JWST-14-1: Complete JWST Spacecraft Critical Design Review (CDR).

FY 2013 JWST-13-1: Deliver James Webb Space Telescope Near Infrared Camera to Integrated Science Instrument Module (ISIM) Integration and Test.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AS04 Green	9AS4 Green	10AS06 Green	JWST-11-1 Green	JWST-12-1 White	JWST-13-1 Green

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Multi-year Performance Goal

FY 2015 and FY 2014 1.6.2: Demonstrate progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity.

FY 2013 2.4.1.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.4.1: "Improve understanding of the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.4.1.1 Green	2.4.1.1 Green	2.4.1.1 Green

FY 2013 Performance Goal Progress Summary

The Astrophysics Subcommittee of the NASA Advisory Committee determined in July 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

Fermi Proves Supernova Remnants Produce Cosmic Rays

A study using observations from NASA's Fermi Gamma-ray Space Telescope revealed the first clear-cut evidence that supernova remnants, the expanding debris of exploded stars, produce some of the fastest-moving matter in the universe. This discovery is a major step toward understanding the origin of cosmic rays, one of Fermi's primary mission goals. About 90 percent of cosmic rays are protons, with the remainder consisting of electrons and atomic nuclei. In their journey across the galaxy, the electrically charged particles are deflected by magnetic fields. This scrambles their paths and makes it impossible to trace their origins directly. Through a variety of mechanisms, these speedy particles can lead to the emission of gamma rays, the most powerful form of light and a signal that travels to Earth directly from its sources.

After analyzing four years of data from Fermi observations of two supernova remnants, IC 443 and W44, scientists saw a distinguishable feature in the gamma-ray emission of both remnants, which provided clear proof that these remnants are producing accelerated protons.

More about this study is available on NASA's site.

Planck Mission Brings Universe into Sharp Focus

Scientists for the Planck space mission released the most accurate and detailed map ever made of the oldest light in the universe, revealing new information about its age, contents, and origins. The map, which is based on the mission's first 15.5 months of all-sky observations, suggest that the universe is expanding more slowly than scientists thought, and is 13.8 billion years old, 100 million years older than previous estimates. The data also show there is less dark energy and more matter, both normal and dark matter, in the universe than previously known.

The map reveals tiny temperature fluctuations in the cosmic microwave background, ancient light that has traveled for billions of years from the very early universe to reach Earth. By showing that matter seems to be distributed randomly, the map suggests that random processes were at play in the very early universe on minute "quantum" scales. This allows scientists to rule out many complex inflation theories in favor of simple ones.

More about this map is available on NASA's site.

NuSTAR Helps Solve Riddle of Black Hole Spin

Two X-ray space observatories, NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) and ESA's XMM-Newton, measured definitively, for the first time, the spin rate of a black hole with a mass two million times that of the Sun. The supermassive black hole lies at the dust- and gas-filled heart of a galaxy called NGC 1365, and it is spinning almost as fast as Einstein's theory of gravity states is possible.

Scientists can trace matter as it swirls into a black hole using X-rays emitted from regions very close to the black hole. The radiation observed is warped and distorted by the motions of particles and the black hole's incredibly strong gravity. Until now, measurements were not certain because clouds of gas could have been obscuring the black holes and confusing the results. With help from XMM-Newton, NuSTAR was able to observe a broader range of X-ray energies and penetrate deeper into the region around the black hole. The new data demonstrate that X-rays are not being warped by the clouds, but by the tremendous gravity of the black hole. This proves that spin rates of supermassive black holes can be determined conclusively. More about these findings is available on NASA's site.

Annual Performance Indicator

Contributing Theme: Astrophysics
Contributing Program(s): Multiple Programs

FY 2015 AS-15-1: Demonstrate planned progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity.

FY 2014 AS-14-1: Demonstrate planned progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity.

FY 2013 AS-13-1: Demonstrate planned progress in understanding the origin and destiny of the universe and the nature of black holes, dark energy, dark matter, and gravity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AS01 Green	9AS1 Green	10AS01 Green	AS-11-1 Green	AS-12-1 Green	AS-13-1 Green

Annual Performance Indicator

Contributing Theme: Astrophysics
Contributing Program(s): Astrophysics Explorer

Does not trend to FY 2015.

FY 2014 AS-14-2: Complete NuSTAR mission success criteria.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 1.6.3: Demonstrate progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe.

FY 2013 2.4.2.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.4.2: "Improve understanding of the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.4.2.1 Green	2.4.2.1 Green	2.4.2.1 Green

FY 2013 Performance Goal Progress Summary

The Astrophysics Subcommittee of the NASA Advisory Committee determined in July 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

Phoenix Cluster Sets Record Pace at Forming Stars

Observations of the Phoenix cluster may force astronomers to rethink how colossal structures and the galaxies that inhabit them evolve. Stars are forming in the Phoenix cluster at the highest rate ever observed for the middle of a galaxy cluster. It also is the most powerful producer of X-rays of any known cluster and among the most massive. The data also suggest that the rate of hot gas cooling in the central regions of the cluster is the largest ever observed. The fast pace of star birth and cooling of gas in the cluster are causing the galaxy and the black hole at the cluster's center to add mass very quickly, an important phase the researchers predict will be relatively short-lived. Otherwise the galaxy and the black hole would become larger than its counterparts in the nearby universe. Because of galaxy clusters' tremendous size, they are crucial objects for studying cosmology and galaxy evolution, so finding one with such extreme properties like the Phoenix cluster is important. Read more on these observations.

Hubble Assembles Farthest-Ever View of the Universe

Astronomers have assembled a new, improved portrait of the deepest-ever, and furthest back in time, view of the universe. Called the eXtreme Deep Field, or XDF, astronomers assembled the photo by

combining 10 years of NASA Hubble Space Telescope photographs taken of a small area of sky at the center of the original Hubble Ultra Deep Field. The new full-color XDF image is even more sensitive, and contains about 5,500 galaxies, even within its smaller field of view. The faintest galaxies are one ten-billionth the brightness of what the human eye can see. Read more about XDF.

Great Observatories Find Candidate for Most Distant Galaxy Yet

Astronomers set a new record for observing the most distant galaxy in the universe. Although it appears as a diminutive blob that is only a tiny fraction of the size of the Milky Way galaxy, it offers a peek back into a time when the universe was three percent of its present age of 13.8 billion years. The galaxy, named MACS0647-JD, was observed 420 million years after the Big Bang, the theorized beginning of the universe. Its light has traveled 13.3 billion years to reach Earth.

The Cluster Lensing And Supernova Survey with Hubble (CLASH) used massive galaxy clusters as cosmic telescopes to magnify distant galaxies behind them. This effect is called gravitational lensing. The cluster's gravity boosted the light from the faraway galaxy, making the images appear brighter than they otherwise would, enabling astronomers to detect the galaxy more efficiently and with greater confidence. Astronomers discovered the galaxy by combining this natural "zoom lens" in space with the power of Hubble and the Spitzer Space Telescope. Read more about this discovery.

Study Suggests Black Holes Abundant Among the Earliest Stars

By comparing infrared and X-ray background signals across the same stretch of sky, a team of astronomers discovered evidence of a significant number of black holes that accompanied the first stars in the universe. Using data from NASA's Chandra X-ray Observatory and Spitzer Space Telescope, they concluded that one of every five sources contributing to the infrared signal is a black hole. These results indicate black holes are responsible for at least 20 percent of the cosmic infrared background, which indicates intense activity from black holes feeding on gas during the epoch of the first stars. Read more about this finding.

Annual Performance Indicator

Contributing Theme: Astrophysics
Contributing Program(s): Multiple Programs

FY 2015 AS-15-2: Demonstrate planned progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe.

FY 2014 AS-14-3: Demonstrate planned progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe.

FY 2013 AS-13-3: Demonstrate planned progress in understanding the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AS06 Green	9AS6 Green	10AS09 Green	AS-11-3 Green	AS-12-3 Green	AS-13-3 Green

Annual Performance Indicator

Contributing Theme: Astrophysics
Contributing Program(s): Cosmic Origins

Does not trend to FY 2015.

FY 2014 AS-14-5: Conduct Stratospheric Observatory for Infrared Astronomy (SOFIA) science flights to provide a minimum of 260 research hours.

FY 2013 AS-13-4: Complete the Systems Requirement Review (SRR) for the initial second generation Stratospheric Observatory for Infrared Astronomy (SOFIA) instrument.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	9AS5 Yellow	10AS07 Yellow	AS-11-4 Green	AS-12-4 Green	AS-13-4 Green

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Multi-year Performance Goal

FY 2015 and FY 2014 1.6.4: Demonstrate progress in discovering and studying planets around other stars and exploring whether they could harbor life.

FY 2013 2.4.3.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.4.3: "Generate a census of extra-solar planets and measure their properties.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.4.3.1 Green	2.4.3.1 Green	2.4.3.1 Green

FY 2013 Performance Goal Progress Summary

The Astrophysics Subcommittee of the NASA Advisory Committee determined in July 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal.

Kepler Broadens the Exoplanet Census

NASA's Kepler mission announced the discovery of nearly 1,300 new planet candidates over the past year, bringing the total to 3,538 planet candidates orbiting 2,658 unique stars. Scientists have confirmed 167 to be planets. The majority of the newly discovered planet candidates are smaller than Neptune, and more than 800 are smaller than twice the size of Earth. They also include nearly 50 planets that orbit in their sun's habitable zone, where liquid water might exist on the surface of a planet. This makes 104 such habitable zone planet candidates discovered, and 10 of those are less than twice the size of Earth and potentially have a rocky composition.

First Planets Found Around Sun-Like Stars in a Cluster

NASA-funded astronomers spotted, for the first time, planets orbiting sun-like stars in a crowded cluster of stars. The findings offer the best evidence yet that planets can sprout up in dense stellar environments. The two newfound planets are so-called hot Jupiters, which are massive, gaseous orbs that are boiling hot because they orbit tightly around their parent stars. Each hot Jupiter circles a different sun-like star in the Praesepe, also called the Beehive Cluster because of the collection of roughly 1,000 stars that appear to be swarming around a common center. The relatively young age of the Beehive cluster makes these planets among the youngest known. This is important because it sets a constraint on how quickly giant planets migrate inward toward their star. And knowing how quickly they migrate is the first step to figuring out how they migrate. Read more about these findings.

Citizen Scientists Discover Four-Star Planet

A joint effort of amateur astronomers and scientists has led to the first reported case of a planet orbiting a double-star that, in turn, is orbited by a second distant pair of stars. The astronomers identified and confirmed discovery of the phenomenon, called a circumbinary planet in a four-star system, aided by volunteer citizen scientists using Kepler data available to the public through Planethunters.org. Only six planets are known to orbit two stars, but none of these are orbited by a distant binary. The volunteers spotted faint dips in light caused by the planet as it passed in front of its parent stars, a common method of finding extrasolar planets. A Yale postdoctoral researcher then led the team of professional astronomers that confirmed the discovery and characterized the planet, following observations from the Keck telescopes on Mauna Kea, Hawaii. Read more about this discovery.

Characterizing Other Worlds

Astronomers working with NASA's Hubble Space Telescope deduced the actual color of a planet orbiting another star 63 light-years away. The planet is HD 189733b, one of the closest exoplanets that can be seen crossing the face of its star, and its color is cobalt blue. If seen directly, this planet would look like a deep blue dot, reminiscent of Earth's color as seen from space. Hubble's Imaging Spectrograph measured changes in the color of light from the planet before, during, and after a pass behind its star. There was a small drop in light and a slight change in the color of the light. The change in color demonstrated that the

planet scatters more blue light than red light. Earlier observations reported evidence for such scattering, and the Hubble observation confirmed the evidence. Read more about this observation.

Astronomers used NASA's Spitzer Space Telescope to make a crude weather map of a hot Jupiter gas giant named HAT-P-2b, which showed huge day-night temperature differences exceeding a thousand degrees. Such temperature differences likely drive ferocious winds blowing thousands of miles per hour. Read more about this study.

Annual Performance Indicator

Contributing Theme: Astrophysics
Contributing Program(s): Multiple Programs

FY 2015 AS-15-5: Demonstrate planned progress in discovering and studying planets around other stars and exploring whether they could harbor life.

FY 2014 AS-14-6: Demonstrate planned progress in discovering and studying planets around other stars and exploring whether they could harbor life.

FY 2013 AS-13-5: Demonstrate planned progress in generating a census of extra-solar planets and measuring their properties. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AS07 Green	9AS7 Green	10AS10 Green	AS-11-5 Green	AS-12-5 Green	AS-13-5 Green

Multi-year Performance Goal

FY 2015 and FY 2014 1.6.5: By December 2018, launch at least one mission in support of Strategic Objective 1.6.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Astrophysics
Contributing Program(s): Astrophysics Explorer

FY 2015 AS-15-4: Complete the Transiting Exoplanet Survey Satellite (TESS) Mission Confirmation Review.

FY 2014 AS-14-7: Complete the Transiting Exoplanet Survey Satellite (TESS) System Requirements Review (SRR).

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

STRATEGIC OBJECTIVE 1.7: TRANSFORM NASA MISSIONS AND ADVANCE THE NATION'S CAPABILITIES BY MATURING CROSSCUTTING AND INNOVATIVE SPACE TECHNOLOGIES.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established next steps for Strategic Objective 1.7, near-term milestones that set the foundation for achieving this objective. For FY 2014, NASA will:

- Continue to explore early stage concepts through support of ongoing efforts as well as solicitation and selection of new technology concepts;
- Advance promising new technologies, including testing of a 5.5 meter composite cryogenic propellant tank and delivery of new technology products to the Human Exploration and Operations Mission Directorate; and
- Mature transformative solutions for flight demonstration, including major testing for the Low Density Supersonic Decelerator project, as well as progression of other technology demonstration projects through major development milestones.

This approach will include continued emphasis on portfolio balance and lean, rapid technology development. NASA also will continue to emphasize partnerships within and outside the Agency.

Strategic Objective Leader: Dorothy Rasco, Deputy Associate Administrator for Management, Space Technology Mission Directorate (STMD)

Multi-year Performance Goal

FY 2015 and FY 2014 1.7.1: Explore and advance promising early stage solutions to space technology challenges through investment across the U.S. innovation community.

FY 2013 3.1.1.1: Develop and advance early stage space technologies that support NASA's science, exploration and discovery missions.

Performance Trending:

FY 2011	FY 2012	FY 2013
3.1.1.1 Green	3.1.1.1 Green	3.1.1.1 Green

FY 2013 Performance Goal Progress Summary

NASA made progress toward achieving this multi-year performance goal as STMD continued to develop and advance early stage space technologies that support science, exploration, and discovery missions.

STMD employed a variety of approaches to achieving this goal. Below are examples of FY 2013 early stage space technology achievements.

Accelerating Development Through Research Grants

NASA accelerates the development of low technology readiness level (TRL) space technologies, through research grants, to support the future space science and exploration needs of NASA, other government agencies, and the commercial space sector. Grants are selected through competitive solicitations for proposals from accredited U.S. universities. Through NASA Space Technology Research Fellowships, Early Career Faculty awards, and Early Stage Innovations awards, NASA's STMD engages a broad spectrum of academic researchers, from graduate researchers to senior faculty members. As a result of these efforts in FY 2013, NASA:

- Supported 120 ongoing research fellowships selected in FY 2011 and 2012, and selected 65 new awards in April 2013. Fellows performed innovative space technology research and made advances in a spectrum of relevant technology areas.
- Supported 10 Early Career Faculty grants, selected in FY 2012, and 10 Early Stage Innovation grants, selected early in FY 2013. Through these grants, NASA progressed innovative, early-stage space technologies for improved radiation shielding and monitoring, spacecraft thermal management, optical systems, and other promising technologies.

Visit the Space Technology Research Grants Web site.

Investing in Innovative and Advanced Concepts

NASA invests in concepts with the potential to transform future aerospace missions, enable new capabilities, or significantly alter and improve current approaches. In FY 2013, NASA:

- Made excellent progress on 18 Phase I and 10 Phase II studies, selected in FY 2012.
- Selected 18 new innovative concept studies (12 Phase I and 6 Phase II) in July and August of 2013, respectively.

These studies represent a broad range of imaginative concepts. Examples include air purification system with no moving parts; a novel manufacturing technique called "SpiderFab" that enables rapid construction of very large, very high strength-per-mass, lattice-like structures; and a system that could use in situ lunar regolith to autonomously build concrete structures on the Moon.

Visit the NASA Innovative Advanced Concepts Web site.

Encouraging Innovation Within NASA's Centers

NASA stimulates and encourages creativity and innovation within the NASA Centers by supporting low-TRL initiatives that leverage Center talent and capability. NASA supported technology development studies at each of the 10 NASA Centers.

- FY 2013 studies represented advancement of innovative approaches in areas spanning all 14 NASA Space Technology Roadmaps.
- FY 2013 investments also enabled partnerships, increasing innovation and cost sharing.

Visit the Center Innovation Fund Web site.

Incentivizing Innovation Through Cash Prizes

NASA provides cash prize incentives to non-traditional sources for innovations of interest and value to the Agency and the Nation. As part of Centennial Challenges, NASA:

- Conducted the 2013 Sample Return Robot Challenge in June 2013, resulting in a level-1 prize award to Team Survey from Los Angeles.
- Released competition rules and opened registration for the Night Rover Challenge and the Unmanned Aircraft Systems Airspace Operations Challenge, both planned for FY 2014.

Visit the Centennial Challenges Web site.

Annual Performance Indicator

Contributing Theme: Space Technology
Contributing Program(s): Crosscutting Space Technology Development

FY 2015 ST-15-1: Research, study, or develop concepts for 150 technologies, as documented in technology reports or plans.

FY 2014 ST-14-1: Research, study, or develop concepts for 150 technologies, as documented in technology reports or plans.

FY 2013 ST-13-1: Research, study, or develop concepts for 120 technologies as documented in technology reports or plans.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	ST-11-1 Green	ST-12-1 Green	ST-13-1 Green

Annual Performance Indicator

Contributing Theme: Space Technology
Contributing Program(s): Crosscutting Space Technology Development

FY 2015 ST-15-2: Conduct at least two Centennial Challenges competitions.

Does not trend to FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8IPP06 Green	None	None	ST-11-2 Green	ST-12-2 Green	None

Multi-year Performance Goal

FY 2015 and FY 2014 1.7.2: Advance technologies that offer significant improvement to existing solutions or enable new space science and exploration capabilities.

FY 2013 3.2.1.1: Develop and advance game-changing and cross-cutting space technologies that support NASA's science, exploration, and discovery missions.

Performance Trending:

FY 2011	FY 2012	FY 2013
3.2.1.1 Green	3.2.1.1 Green	3.2.1.1 Green

FY 2013 Performance Goal Progress Summary

NASA made progress toward achieving this multi-year performance goal as STMD continued to develop and advance game changing and crosscutting space technologies that support science, exploration, and discovery missions. STMD employed a variety of approaches in the Agency's continual pursuit of game changing and crosscutting technology breakthroughs. Below are examples of some of FY 2013 achievements.

Improving Existing Capabilities and Advancing Promising New Technology Solutions

STMD continues to deliver improvements to existing capabilities, while also advancing promising new technology solutions that have the potential to revolutionize future space missions and provide solutions to significant national needs. For example, during FY 2013, STMD:

- Completed feasibility studies, ground demonstrations, and/or laboratory experiments for the following three new technologies: Barrier Infra Red Detector, Battery Anode Award (AMPRIUS), and Woven Thermal Protection System.
- Successfully tested a novel 2.4-meter diameter composite cryogenic fuel tank. These tests pave the way for planned FY 2014 testing of a 5.5-meter tank, the largest out-of-autoclave composite cryogenic tank ever built, which could provide a significant increase in Space Launch System payload capacity.
- Made the following achievements: successful testing of an additive-manufactured RL10 rocket engine injector; creation of a synthetic "bio brick" composite material that could apply to in-space construction, development of dexterous Robonaut legs for FY 2014 delivery to ISS; development

and infusion of a multi-layer insulation material; and testing of high-powered hall thrusters for long-duration use.

Visit the Game Changing Development Web site.

Employing the Unique Features of Small Spacecraft

NASA develops and demonstrates new capabilities employing the unique features of small spacecraft for science, exploration and space operations. As part of this effort, STMD:

- Successfully launched and operated smartphone-based nanosatellites as a rideshare on the inaugural Orbital Antares launch in April 2013. These PhoneSats are the lowest cost satellites NASA has ever flown in space.
- Made significant progress on other small spacecraft demonstration projects, including (but not limited to) transition to the implementation phase of project development for both the Edison Demonstration of Smallsat Networks, (i.e., demonstration of network capabilities within a swarm of eight cubesats), and the Cubesat Proximity Operations Demonstration.
- Selected 13 university small spacecraft projects for collaboration.

Visit the Small Spacecraft Technology Web site.

Maturing Crosscutting Technologies to Flight-Ready Status

Charged with proving revolutionary, crosscutting technologies—ones that could radically advance NASA's Mission in space and reap untold benefits for science and industry here on Earth—STMD seeks to mature laboratory-proven technologies to flight-ready status. In this area, STMD made significant progress on several technology demonstration projects, including (but not limited to) transition to the implementation phase of project management for the Solar Sail and Green Propellant Infusion Mission projects.

Visit the Technology Demonstration Mission Web site.

Providing Flight Opportunities

NASA develops and provides flight opportunities for space technologies to be demonstrated and validated in relevant environments. During FY 2013, STMD flew technology payloads on flight campaigns conducted by four different commercial providers, including the first flight campaign on UP Aerospace Inc.'s SpaceLoft 7 vehicle.

Visit the Flight Opportunities Web site.

Annual Performance Indicator

Contributing Theme: Space Technology
Contributing Program(s): Crosscutting Space Technology Development

FY 2015 ST-15-3: Complete at least four feasibility studies, ground demonstrations, or laboratory experiments proving the technical feasibility of new space technologies.

FY 2014 ST-14-2: Complete at least seven feasibility studies, ground demonstrations, or laboratory experiments proving the technical feasibility of new space technologies.

FY 2013 ST-13-2: Complete three feasibility studies, ground demonstrations, or laboratory experiments proving the technical feasibility of new space technologies.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	ST-11-7 Green	ST-12-7 Green	ST-13-2 Green

Multi-year Performance Goal

FY 2015 and FY 2014 1.7.3: Mature new crosscutting space technology capabilities for demonstration.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Space Technology
Contributing Program(s): Crosscutting Space Technology Development

FY 2015 ST-15-4: Complete two Key Decision Points for small spacecraft projects to demonstrate game changing or crosscutting technologies in space.

FY 2014 ST-14-3: Complete four Key Decision Points for small spacecraft projects to demonstrate game changing or crosscutting technologies in space.

FY 2013 ST-13-3: Implement at least one new small spacecraft mission that was selected in the previous fiscal year to demonstrate game changing or crosscutting technologies in space.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	ST-12-9 Green	ST-13-3 Green

Annual Performance Indicator

Contributing Theme: Space Technology
Contributing Program(s): Crosscutting Space Technology Development

FY 2015 ST-15-5: Complete three Key Decision Points for Technology Demonstration Mission (TDM) technology development projects.

FY 2014 ST-14-4: Complete three Key Decision Points for Technology Demonstration Mission (TDM) technology development projects.

FY 2013 ST-13-4: Implement at least two Technology Demonstration Missions (TDM) technology development projects that were initiated in the previous two years.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	ST-11-10 Green	ST-12-10 Green	ST-13-4 Green

Annual Performance Indicator

Contributing Theme: Space Technology
Contributing Program(s): Crosscutting Space Technology Development

FY 2015 ST-15-6: Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least five different commercial reusable suborbital or parabolic platform providers.

FY 2014 ST-14-5: Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least four different commercial reusable suborbital or parabolic platform providers.

FY 2013 ST-13-5: Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least three different commercial reusable suborbital or parabolic platform providers.

PERFORMANCE REPORTING AND PLANNING

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	ST-11-11 Green	ST-12-11 Green	ST-13-5 Green

Strategic Goal 2: Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.

STRATEGIC OBJECTIVE 2.1: ENABLE A REVOLUTIONARY TRANSFORMATION FOR SAFE AND SUSTAINABLE U.S. AND GLOBAL AVIATION BY ADVANCING AERONAUTICS RESEARCH.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established FY 2014 next steps for Strategic Objective 2.1 by defining near-term milestones that set the foundation for achieving this objective.

- Reorganize Aeronautics Research Mission Directorate (ARMD) programs to execute the strategy more efficiently.
- Complete progress indicator maps for each Technical Challenge. These maps will serve as the basis for measuring progress toward the strategic objective.
- Align ARMD research to six long-term research thrusts: safe, efficient growth in global operations; innovation in commercial supersonic aircraft; ultra-efficient commercial vehicles; transition to low-carbon propulsion; real-time, system-wide safety assurance; and assured autonomy for aviation transformation.

ARMD's FY 2014 research will focus on:

- Reducing aircraft safety risks and increasing operational efficiency of air traffic management systems;
- Developing and maturing portfolios of advanced airframe and engine technologies to achieve aggressive energy efficiency, noise, and emissions goals;
- Continuing progress on reducing barriers to routine access of unmanned aircraft systems (UAS) in the National Airspace System (NAS);
- Supporting national efforts to transition to alternative fuels and pioneer low carbon propulsion;
- Accelerating the detection and prognosis of system-wide safety threats;
- Taking first steps towards demonstrating the feasibility of low-boom supersonic vehicles; and
- Establishing confidence in the safety of new automation software systems.

Strategic Objective Leader: Tom Irvine, Deputy Associate Administrator, ARMD

Multi-year Performance Goal

FY 2015 and FY 2014 2.1.1: Develop solutions that will advance decision-making ability for improving air traffic management to accommodate future growth in air travel, and for increasing aviation safety under hazardous conditions.

FY 2013 4.1.2.1: Demonstrate advanced technologies and solutions to achieve fuel efficient increases in operational performance of the Next Generation Air Transportation System (NextGen) while reducing noise and emissions.

Performance Trending:

FY 2011	FY 2012	FY 2013
4.1.2.1 Green	4.1.2.1 Green	4.1.2.1 Green

Note: In FY 2015, ARMD will implement a restructured organization that aligns with the aeronautics strategic priorities. Consequently, activities under the program-based performance goals from the 2011 Strategic Plan will transition to multiple new strategically based performance goals. Performance Goal 4.1.1.1 also trends to new Performance Goal 2.1.1.

FY 2013 Performance Goal Progress Summary

NASA officially presented the prototype software for its Precision Departure Release Capability (PDRC) to the Federal Aviation Administration (FAA) in August 2013. With PDRC, controllers will be able to improve the overall efficiency of air traffic management by reducing missed or delayed departures and allowing more aircraft to depart within a given timeframe. Tests of the software conducted during the past few years show that PDRC could help improve compliance with the departure time by up to 80 percent, thereby improving the use of slots in the overhead stream of air traffic that can go empty due to timing issues on the ground. Testing and evaluation of the PDRC software was done during two series of exercises conducted at NASA's North Texas Research Station near the Dallas/Fort Worth International Airport beginning in May 2012 and concluding early in 2013. During the evaluation, FAA controllers used the prototype PDRC system to schedule departure times for real, operational airline flights. The PDRC software tool is the latest example in a long history of NASA's technical contributions to the aviation community. Read more about the PDRC transfer at http://www.nasa.gov/aero/pdrc_transfer.html.

NASA conducted a field trial with American Airlines for NASA's Dynamic Weather Routing (DWR), a tool that continually analyzes flight trajectories and weather conditions and then suggests course corrections to avoid the trouble. Field trials like these are the final step required before NASA delivers the DWR tool to carriers and system developers for improved flight efficiencies and cost savings.

NASA conducted the most recent testing for the Spot and Runway Departure Advisor (SARDA) during summer 2013. SARDA is a decision support tool that helps to improve the efficiency of departure operations on taxiways and runways. While previous simulations included participation by controllers, this simulation was the first time pilots were also included. Using over 120 current and future operational scenarios, controllers used SARDA to plan and issue gate release and departure clearances to the pilots for execution. Early simulation results suggest that sharing the controller's SARDA information with the

pilots enabled improved coordination, and allowed the aircrews to meet the controller's SARDA plans more accurately.

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Aviation Safety

Does not trend to FY 2015.

FY 2014 AR-14-3: Provide an integrated, high-fidelity simulator demonstration of an aerodynamic model that supports flight crew training requirements for assuring safe aircraft control.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AT02 Green	9AT1 Green	10AT03 Green	AR-11-2 Green	AR-12-3 Green	None

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Airspace Operations and Safety

FY 2015 AR-15-1: Demonstrate the Concept of Operations for an integrated set of aircraft arrival technologies (ATD-1) that will provide for efficient performance during congested operations at busy airports.

Contributing Theme: Aeronautics
Contributing Program(s): Airspace Systems

FY 2014 AR-14-4: Develop a scheduling tool that reduces departure delays by enabling efficient aircraft departure and merging into open slots in the congested overhead traffic stream.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10AT06 Green	AR-11-4 Green	AR-12-6 Green	None

Multi-year Performance Goal

FY 2015 and FY 2014 2.1.2: Demonstrate the ability to reduce sonic booms, enabling future industry innovation in commercial supersonic aircraft.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Note: In FY 2015, ARMD will implement a restructured organization that aligns with the aeronautics strategic priorities. Consequently, activities under the program-based performance goals from the 2011 Strategic Plan will transition to multiple new strategically based performance goals. Performance Goals 4.1.3.1 and 4.2.1.1 trend to new Performance Goal 2.1.2.

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Advanced Air Vehicles

FY 2015 AR-15-2: Complete low sonic boom design tools capable of analyzing a complete aircraft at all supersonic flight conditions.

Contributing Theme: Aeronautics
Contributing Program(s): Fundamental Aeronautics

FY 2014 AR-14-12: Complete Low Boom Flight Demonstrator (LBFD) conceptual design.

FY 2013 AR-13-5: Validate high fidelity tools for sonic boom and drag prediction to enable the design of future supersonic air vehicles.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AT11 Yellow	9AT9 Green	10AT09 Green	AR-11-8 Green	AR-12-10 Green	AR-13-5 Green

Multi-year Performance Goal

FY 2015 and FY 2014 2.1.3: Advance airframe and engine technologies to enable the development of future generations of ultra efficient aircraft that minimize environmental impact.

FY 2013 4.1.3.1: Deliver tools, technologies, and knowledge that can be used to more efficiently and effectively design future air vehicles and their components to overcome national performance and capability challenges.

Performance Trending:

FY 2011	FY 2012	FY 2013
4.1.3.1 Green	4.1.3.1 Green	4.1.3.1 Green

Note: In FY 2015, ARMD will implement a restructured organization that aligns with the aeronautics strategic priorities. Consequently, activities under the program-based performance goals from the 2011 Strategic Plan will transition to multiple new strategically based performance goals. Performance Goal 4.2.1.1 also trends to new Performance Goal 2.1.3.

FY 2013 Performance Goal Progress Summary

Aircraft noise limits the ability to increase air traffic throughput in order to meet projected increased demand for air travel. NASA has been at the forefront of developing and providing tools to industry that characterize the community impact of aircraft noise, especially through its comprehensive Aircraft Noise Prediction Program (ANOPP) code, which predicts the noise created by the entire aircraft and the noise impact on the ground. NASA recently developed the next generation ANOPP2 and in FY 2013, validated it with wind tunnel data. ANOPP2's new capabilities include predicting noise created by advanced aircraft configurations, which are very different from the conventional tube-and-wing aircraft in use today, and the effects of atmosphere and local terrain in noise propagation. ANOPP2 will allow more accurate prediction of noise impact on communities for current generation aircraft and enable accurate noise impact assessments of future aircraft designs.

NASA is exploring advances to make air travel even more flexible and convenient by seeking ways to increase the use of helicopters in the air transportation system. The goal is to make modern helicopters quieter and more fuel-efficient so that they can safely carry more people and cargo and be more effective in conducting current missions and new missions, such as increased delivery and transportation. To support this, NASA made significant advances in rotary wing propulsion systems in FY 2013 that included new types of engine compressors and turbines and new transmissions. To make rotorcraft quieter, NASA also measured and studied the noise of helicopters doing complicated turns and landings. NASA's concern for air traffic safety created new efforts to examine helicopters operating in bad weather. In August 2013, NASA crashed a helicopter fuselage in its ongoing effort to improve helicopter safety. Using the drop test facility at Langley Research Center, NASA dropped the fuselage 30 feet, simulating a severe but survivable crash. Crash-test dummies served as passengers in the test. The goal was to test improved seat belts and seats, to collect crashworthiness data, and to check out some new test methods. The drop also provided data that will serve as a baseline for another test scheduled for late 2014. Find out more at http://www.nasa.gov/aero/chopper_drop_success.html. NASA worked to reduce problems caused by ice forming on the rotor blades through a wind tunnel test at Glenn Research Center in summer 2013,

and to understand how pilots can control helicopters at night and in bad weather through a simulation test at Ames Research Center in June 2013.

Faster vehicles are another way to make air travel more convenient for the flying public. NASA is helping to achieve faster air travel by working on technology that would enable high performance supersonic transports to fly commercially with virtually no noise impact on the ground from sonic booms. NASA completed extensive ground testing in spring 2013 to validate its high fidelity computational tools that predict sonic boom and aircraft drag. NASA achieved good to excellent comparisons between test data and the predictions for both sonic boom and aircraft performance, thereby providing confidence in the accuracy of its most advanced computational tools. These tools eventually may be used to help design new types of aircraft.

To help reduce the impact of air travel on the environment, NASA completed Phase 1 of the in-flight tests to characterize the emissions from aircraft engines burning an alternative biofuel. These tests complement the ground-based tests completed in prior years. Preliminary results indicate that the biofuel blends tested may substantially reduce the emission of black carbon, sulfates, organics, and other particulates. This Phase 1 flight testing has resulted in an internationally recognized data set that is being used for input to climate change models and is informing the development of aviation emission standards.

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Aeronautics Test

Does not trend to FY 2015.

FY 2014 AR-14-10: Execute data acquisition and control systems upgrades for the Glenn Research Center 10x10-Foot Supersonic Wind Tunnel.

FY 2013 AR-13-8: Provide a new engine icing test capability to address the high-altitude engine icing problem encountered by commercial aircraft.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	AR-13-8 Green

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Aeronautics Test

Does not trend to FY 2015.

FY 2014 AR-14-11: Execute data measurement techniques and flow quality improvements at the Langley Research Center National Transonic Facility.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Fundamental Aeronautics

Does not trend to FY 2015.

FY 2014 AR-14-5: Use highly-detailed experimental and computer simulations to determine the potential of the truss-braced wing technology concept to enable reduced fuel use in transport aircraft.

FY 2013 AR-13-4: Develop, improve, and validate a multi-fidelity toolset to assess the noise characteristics of future subsonic aircraft.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AT07 Green	9AT7 Green	10AT07 Green	AR-11-6 Green	AR-12-8 Green	AR-13-4 Green

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Integrated Aviation Systems

FY 2015 AR-15-3: Develop and analyze vehicle concepts with the appropriate technology suite to simultaneously meet fuel burn, community noise, and Landing and Take-off Nitrogen Oxides subsonic transport goals by the 2020-2025 timeframe.

Contributing Theme: Aeronautics
Contributing Program(s): Integrated Systems Research

FY 2014 AR-14-7: Demonstrate Ultra High Bypass (UHB) propulsion systems can be integrated with Hybrid Wing Body (HWB) concepts to meet fuel burn and noise goals.

FY 2013 AR-13-6: Conduct tests to validate low-noise characteristics of a hybrid wing body aircraft concept.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10AT12 Yellow	AR-11-10 Green	AR-12-12 Green	AR-13-6 Green

Annual Performance Indicator

Does not trend to FY 2015.

Contributing Theme: Aeronautics
Contributing Program(s): Integrated Systems Research

FY 2014 AR-14-9: Conduct a successful Project Formulation Review and establish an advanced composites consortium to accelerate the development and certification process for advanced composite structures.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 2.1.4: Facilitate significant environmental and efficiency improvements through research on alternative jet fuel use and on hybrid gas-electric propulsion system concepts.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Note: In FY 2015, ARMD will implement a restructured organization that aligns with the aeronautics strategic priorities. Consequently, activities under the program-based performance goals from the 2011 Strategic Plan will transition to multiple new strategically based performance goals. Performance Goal 4.1.3.1 trends to new Performance Goal 2.1.4.

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Advanced Air Vehicles

FY 2015 AR-15-4: Characterize gaseous and particulate cruise emissions of biofuel-blended jet fuels and effects of fuel sulfur during flight at cruise conditions.

Contributing Theme: Aeronautics
Contributing Program(s): Fundamental Aeronautics

FY 2014 AR-14-13: Model and design a fully superconducting electric generator for novel aircraft propulsion applications.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 2.1.5: Significantly increase the ability to anticipate and resolve potential safety issues and predict the health and robustness of aviation systems.

FY 2013 4.1.1.1: Transfer knowledge to the aviation community to better manage safety in aviation.

Performance Trending:

FY 2011	FY 2012	FY 2013
4.1.1.1 Green	4.1.1.1 Green	4.1.1.1 Green

Note: In FY 2015, ARMD will implement a restructured organization that aligns with the aeronautics strategic priorities. Consequently, activities under the program-based performance goals from the 2011 Strategic Plan will transition to multiple new strategically based performance goals. Performance Goal 4.1.2.1 also trends to new Performance Goal 2.1.5.

FY 2013 Performance Goal Progress Summary

During FY 2013, NASA calibrated and validated a computational tool used to assess the risk of engine ice crystal icing. NASA anticipates that this tool will be available to the engine manufacturers to use during the design process to mitigate the impact of ice crystal icing. This form of icing has been reported to cause engine power loss events under certain atmospheric conditions generally attributed to high

altitude thunderstorms. Researchers hypothesize that solid ice crystals partially melt when entering the warmer engine environment, and then may refreeze on parts of the engine compressor, leading to a loss of engine power. NASA conducted calibration tests using a jet engine known to be susceptible to ice crystal icing. The tests were the first to be conducted in the Propulsion Systems Laboratory (PSL) at Glenn Research Center. The testing confirmed the conditions that the computational tool predicted would lead to engine power loss events and will provide test data that supports certification of future jet engines. Read more about NASA's work in ice crystal icing. A NASA video is available at http://youtu.be/laHM-VKSY0A.

NASA also completed the second major test in a series intended to evaluate the capabilities of new engine sensors and diagnostic systems. The first test was conducted during 2012. NASA worked with multiple industry and government partners to conduct the ground-based tests on a C-17 aircraft engine, and the knowledge gained thus far has been communicated to the aviation community. During the test series, NASA and its partners successfully demonstrated the capability of NASA-developed health management technologies to detect and diagnose incipient engine faults before they cause a safety problem. The tests have given NASA a first opportunity to evaluate the capabilities under the high temperature and vibration environment associated with an operating aircraft engine.

NASA and its partners established the technical feasibility of a vehicle-level prognostic reasoning system. This system would offer an onboard capability to provide additional warning about potential aircraft system failures that could degrade safety. The information could allow pilots or maintenance personnel to take necessary steps to ensure continued safe operation. The prognostic reasoning system combines onboard system measurements with a data mining capability to detect out-of-the-ordinary, or anomalous, conditions. Using this approach, the reasoning system compares onboard conditions with historical data linked to actual failures. Pilots and maintenance personnel would be notified when the system detects an anomaly. Designers used subject-matter experts during the development of this system to improve the system's ability to detect potential problems correctly, while limiting the number of false detections. During the multi-year activity that completed in 2013, NASA and its partners used a prototype reasoning system to correctly predict three safety incidents from a set of regional airline flight data. The system also correctly detected and provided advanced warning of four faults that were injected into an aircraft navigation system. To improve opportunities for technology transfer, NASA and its partners tested the reasoning system using existing aircraft hardware, software, and communication protocols.

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Aviation Safety

Does not trend to FY 2015.

FY 2014 AR-14-1: Conduct a ground-based demonstration of a wireless sensor that provides lightning protection and can detect and diagnose damage in composite structures.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	AR-12-1 Green	None

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Transformative Aeronautics Concepts

FY 2015 AR-15-5: Demonstrate that aircraft engine diagnostic systems that rely on advanced sensors can detect faults and hazards between maintenance inspections.

Does not trend to FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 2.1.6: Support transformation of civil aircraft operations and air traffic management through the development, application, and validation of advanced autonomy and automation technologies, including addressing critical barriers to future routine access of Unmanned Aircraft Systems (UAS) in the National Airspace System, through the development and maturation of technologies and validation of data.

FY 2013 4.2.1.1: Reduce technical risk by conducting research at an integrated system-level on promising aeronautical concepts and technologies in a relevant environment.

Performance Trending:

FY 2011	FY 2012	FY 2013
4.2.1.1 Green	4.2.1.1 Green	4.2.1.1 Green

Note: In FY 2015, ARMD will implement a restructured organization that aligns with the aeronautics strategic priorities. Consequently, activities under the program-based performance goals from the 2011 Strategic Plan will transition to multiple new strategically based performance goals. Performance Goals 4.1.1.1 and 4.1.2.1 also trend to new Performance Goal 2.1.6.

FY 2013 Performance Goal Progress Summary

During FY 2013, NASA continued to make progress towards reducing or eliminating technical barriers to safe and routine access of UAS into the National Airspace System for civil use. Based on the results of earlier analysis and testing, NASA, in close partnership with FAA and other regulatory bodies, planned for future technology development focusing on the most critical needs for safe UAS integration and meeting the most immediate requirements of the regulatory bodies. This research will be validated through future flight testing over the next few years.

In September 2013, NASA completed a series of characterization tests of a unique flight test environment for UAS research called the Live Virtual Constructive–Distributed Environment (LVC-DE) in order to establish a baseline of the system's capabilities. During the tests, LVC-DE allowed live unmanned and manned aircraft operators to interact with virtual unmanned and manned aircraft operators, supported by actual and simulated air traffic data from air traffic control facilities and ground control stations. The result was safe but realistic testing of UAS integration concepts and flight characteristics. Read more about the LVC-DE testing.

NASA also explored technologies and procedures that can guarantee seamless communication between UAS, air traffic controllers, and other pilots. In February 2013, NASA began working with industry to develop a specially designed radio for use by UAS that would enable secure command-and-control communications between the ground and the aircraft. Over the course of seven flights, engineers characterized the frequencies that would be used and investigated how they interact with various topographical and climatological conditions around the United States to ensure uninterruptable two-way transmission.

NASA successfully completed testing in the Langley Research Center's 14x22-Foot Subsonic Wind Tunnel to demonstrate the noise reduction potential of the Hybrid Wing Body (HWB) aircraft configuration, shown here. This testing investigated the combined airframe and jet engine noise using a HWB model and a compact jet engine noise simulator. It also characterized the ability of the HWB airframe to "shield" emitted noise. Results indicated that the HWB configuration will meet the goal of 42 decibel noise reduction from existing noise standards. This validated the anticipated noise reduction benefits and provides the industry with validation data that supports future aircraft design investment decisions. To enable the testing, NASA made numerous upgrades to the wind tunnel, further augmenting this critical national asset for future research needs.

NASA also used the 14x22-Foot Subsonic Wind Tunnel in support of research investigating the potential for noise reduction in aircraft flaps and landing gear, major components of structural noise generation in aircraft, while minimizing weight and integration penalties. NASA performed detailed evaluations of six selected flap noise reduction concepts on a semi-span model of a Gulfstream G550 aircraft. The testing was performed both alone and with landing gear noise reduction concepts. Data from these test runs were used to down select the most promising flap and gear noise reduction technologies, which will be manufactured in full-scale and flight tested on a real G550 in 2014.

NASA conducted significant planning for a new Advanced Composites project during FY 2013. NASA's objective in this five-year project is to significantly accelerate the timeline to bring innovative aerospace composite materials/structures to market, which today can exceed 20 years or more, through the development of next-generation, physics-based tools and streamlined processes. In August 2013, NASA,

in conjunction with the Aeronautics Research and Technology Roundtable of the National Research Council, met to discuss and validate the project's goals, objectives, and approach.

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Aviation Safety

Does not trend to FY 2015.

FY 2014 AR-14-2: Demonstrate use of an advanced software technique to verify the safety of a complex aircraft or ground automation software system.

FY 2013 AR-13-2: Develop onboard capabilities that aid in-flight decision-making through instantaneous health assessment of aircraft systems.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10AT01 Green	AR-11-1 Green	AR-12-2 Green	AR-13-2 Green

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Integrated Aviation Systems

FY 2015 AR-15-7: Deliver data, analysis, and recommendations based on an integrated flight test series with simulated airspace/traffic and a live vehicle to inform development of preliminary performance standards by the RTCA Special Committee on Minimum Performance Standards for Unmanned Aircraft Systems.

Contributing Theme: Aeronautics
Contributing Program(s): Integrated Systems Research

FY 2014 AR-14-8: Conduct a human-in-the-loop (HiTL) simulation where unmanned aircraft are mixed with manned aircraft and subjected to a range of test conditions.

FY 2013 AR-13-7: Complete flight evaluations to assess the capabilities of the Live, Virtual, Constructive (LVC) distributed simulation environment.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	AR-12-13 Green	AR-13-7 Green

Annual Performance Indicator

Contributing Theme: Aeronautics
Contributing Program(s): Integrated Aviation Systems

FY 2015 AR-15-6: Implement Automatic Dependent Surveillance-Broadcast Out (ADS-B Out) capability on select flight test support aircraft to enable the testing of operational design solutions that enable safe, efficient growth in global operations.

Does not trend to FY 2014.

FY 2013 AR-13-9: Perform a condition assessment of the ground support facilities, systems, and equipment within the Flight Test Project portfolio.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	AR-13-9 Green

STRATEGIC OBJECTIVE 2.2: ADVANCE KNOWLEDGE OF EARTH AS A SYSTEM TO MEET THE CHALLENGES OF ENVIRONMENTAL CHANGE, AND TO IMPROVE LIFE ON OUR PLANET.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established FY 2014 next steps for Strategic Objective 2.2, near-term milestones that set the foundation for achieving this objective.

- Prepare for Orbiting Carbon Observatory (OCO)-2 launch in FY 2014 and Soil Moisture Active Passive (SMAP) launch in FY 2015.
- Select Earth Venture Instrument (EVI)-2 and Earth Venture Suborbital (EVS)-2 investigations for the Earth Venture Program.
- Conduct the Critical Design Review (CDR) for the Ice, Cloud, and Land Elevation Satellite (ICESat)-2. After completing CDR, the project will proceed with final design and fabrication of ICESat-2.
- Conduct Key Decision Point (KDP)-C reviews for the Cyclone Global Navigation Satellite System (CYGNSS) and the Gravity Recovery and Climate Experiment (GRACE) Follow-On (FO). At KDP-C, a Standing Review Board will determine if each project has adequately set its requirements, with acceptable risk and estimated lifecycle cost and schedule baseline, and has set a project and science plan.
- Conduct KDP-B for Tropospheric Emissions: Monitoring of Pollution (TEMPO) and Surface Water Ocean Topography (SWOT). At KDP-B, the project transitions into the detailed design phase.
- In partnership with the Indian Space Research Organisation (ISRO), conduct KDP-A for the NASA–ISRO SAR (Synthetic Aperture Radar), or NISAR, mission. At KDP-A, the Review Board will review the mission's preliminary concept and requirements, allowing the project to begin formulation.
- Conduct a Sustained Land Imaging Architecture Study. This is a first step to ensuring the continuity of space-based, global land imaging capability following the Landsat-8 mission (formerly the Landsat Data Continuity Mission, or LDCM). NASA is leading this overall system architecture study, with support from the U.S. Geological Survey.

Strategic Objective Leader: Dr. Michael Freilich, Director of Earth Science Division, Science Mission Directorate

Multi-year Performance Goal

FY 2015 and FY 2014 2.2.1: Demonstrate progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.

FY 2013 2.1.1.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.1: "Improve understanding of and improve the predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.1.1.1 Green	2.1.1.1 Green	2.1.1.1 Green

FY 2013 Performance Goal Progress Summary

The Earth Science Subcommittee of the NASA Advisory Committee determined in September 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

In the past year, there was an increase in studies using multiple space-based observations to address issues of societal relevance, like air quality and health, at regional and local levels. They addressed a wide range of topics: improving the accuracy of daily satellite-derived ground-level fine aerosol concentration estimates for North America using the Moderate-Resolution Imaging Spectroradiometer (MODIS) and Multi-Angle Imaging Spectroradiometer (MISR); validating MODIS, MISR, Ozone Monitoring Instrument (OMI), and the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) aerosol optical thickness using ground-based instruments in Hong Kong for air quality applications; clarifying the variability of outdoor fine particulate concentration in the India subcontinent using MISR observations; and using MODIS aerosol products to improve understanding of the global dust cycle. Changes in dust emissions can impact climate, air quality, and human health. One study made significant progress in bounding the role of black carbon, a type of atmospheric pollutant, in the climate system. It provided an evaluation of black carbon climate forcing that included all known and relevant processes. This study set a baseline from which to improve future climate forcing estimates, by evaluating the large number and complexity of the associated physical and radiative processes in black carbon climate forcing.

Initial measurements of the vertical distribution of ozone made by the Suomi National Polar-orbiting Partnership (NPP) satellite Ozone Mapping and Profiler Suite (OMPS) were released in late 2012. OMPS measurements captured the evolution of the Antarctic ozone hole, the second-smallest hole since the mid-1980s, from its formation in early September to its dissolution in late October. OMPS also detected and tracked global transport of dust produced by the February 15, 2013, explosion of the meteor, Chelyabinsk, over Siberia. A detectable belt of dust persisted around the planet at least three months later. Read more about the meteor.

In the past year, NASA researchers participated in the Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys (SEAC4RS) airborne field campaign, which started in late July 2013 from Palmdale, CA, and ended in late September. Among the key mission objectives was the investigation of vertical transport in the North American monsoon over southwest North America, emissions produced by biological processes in convection over southeast North America, pollutants in mesoscale convective systems over central North America, emissions from marine and

human sources in clouds and tropical storms in the Gulf of Mexico, and emissions from forest fires in northwest North America.

Other NASA field campaigns included the following:

- The Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE), which flew its 320th science flight hour during July 2013, successfully completed its investigation of the sensitivities of Arctic carbon cycle processes to climate change.
- The Airborne Tropical Tropopause Experiment (ATTREX) conducted its first science flights with the Global Hawk unmanned aircraft system. ATTREX made six flights lasting 24 hours or more. It targeted the deep tropics over the central and eastern Pacific and obtained over 100 vertical profiles in the Tropical Tropopause layer, clarifying its role in atmospheric chemistry and climate.
- The EV-1 DISCOVER-AQ mission operates as a complex observing system employing two NASA aircraft and an extensive ground network. It provided multiple perspectives on the factors that control air quality and influence the ability to monitor pollution from space.

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Multiple Programs

FY 2015 ES-15-1: Demonstrate planned progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.

FY 2014 ES-14-1: Demonstrate planned progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.

FY 2013 ES-13-1: Demonstrate planned progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES01 Green	9ES1 Green	10ES01 Green	ES-11-1 Green	ES-12-1 Green	ES-13-1 Green

Multi-year Performance Goal

FY 2015 and FY 2014 2.2.2: Demonstrate progress in improving the capability to predict weather and extreme weather events.

FY 2013 2.1.2.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.2: "Enable improved predictive capability for weather and extreme weather events.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.1.2.1 Green	2.1.2.1 Green	2.1.2.1 Green

FY 2013 Performance Goal Progress Summary

The Earth Science Subcommittee of the NASA Advisory Committee determined in September 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

In 2002, after the launch of NASA's Aqua spacecraft, the European Centre for Medium-Range Weather Forecasts (ECMWF) was the first center to adopt operational use of Aqua's Atmospheric Infrared Sounder (AIRS) data. Major Numerical Weather Prediction (NWP) centers in the United States, including NOAA's National Center for Environmental Prediction, NASA's Global Modeling and Assimilation Office, and the U.S. Navy, also have shown notable improvements from the assimilation of AIRS data into their operational forecast systems. A study concluded that a consensus exists among NWP centers that AIRS is one of the highest-ranked contributors to forecast skill of any Earth remote sensing instrument.

A recent study used a set of data assimilation and forecast experiments, performed with the NASA global data assimilation and forecast system Goddard Earth Observing System Model version 5, or GEOS-5, to compare the impact of different approaches toward assimilation of AIRS data. The study (called AIRS v5) results show that the assimilation of quality-controlled AIRS temperature retrievals obtained under partly cloudy conditions produce better precipitation analyses and substantially better seven-day forecasts, as well as improve the global forecast skill, than assimilation of clear-sky radiances. Information provided from AIRS v5 cloudy retrievals allow an improved representation of the low- and mid-level moist atmospheric flow from the Indian Ocean, on different time scales. The resulting improved precipitation analyses arise out of an improved representation of cloudiness distribution, moisture transport, and convergence. Improved precipitation forecast may enable better hydrological forecasts.

Another study focused on quantifying the relationship of large-scale environmental conditions such as relative humidity with hurricane intensity. Hurricane intensity change is important for statistical hurricane intensity forecasts. Composite analysis of nine years of AIRS humidity data, spanning 198 Atlantic tropical cyclones, shows that environmental relative humidity above the boundary layer generally decreases with time as tropical cyclones evolve. Near the surface, environmental relative humidity stays approximately constant. It generally increases with increasing tropical cyclone intensity and intensification rate. Tropical cyclones that rapidly intensify are associated with free tropospheric environmental relative humidity more than 10 percent (relative to the averaged environmental relative humidity for all tropical cyclones) larger than that for weakening tropical cyclones. The environmental relative humidity gradient weakens with the decrease of intensification rate. This radial gradient might be a useful predictor for the statistical forecast of tropical cyclone intensification.

NASA continued planned deployments for the Hurricane and Severe Storm Sentinel (HS3) five-year Earth Venture class suborbital mission, which was awarded in 2010. Two Global Hawk unmanned aircraft systems with distinct payloads use the Wallops Island Flight Facility on the coastline of Virginia during the hurricane seasons of 2012-2014 for easy access to Atlantic, Gulf of Mexico, or Caribbean storms. The HS3 mission is designed to investigate basic questions regarding changes in hurricane intensity.

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Multiple Programs

FY 2015 ES-15-2: Demonstrate planned progress in improving the capability to predict weather and extreme weather events.

FY 2014 ES-14-3: Demonstrate planned progress in improving the capability to predict weather and extreme weather events.

FY 2013 ES-13-3: Demonstrate planned progress in enabling improved predictive capability for weather and extreme weather events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES02 Green	9ES7 Green	10ES04 Green	ES-11-5 Green	ES-12-4 Green	ES-13-3 Green

Multi-year Performance Goal

FY 2015 and FY 2014 2.2.3: Demonstrate progress in detecting and predicting changes in Earth's ecological and chemical cycles, including land cover, biodiversity, and the global carbon cycle.

FY 2013 2.1.3.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.3: "Quantify, understand, and predict changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.1.3.1 Green	2.1.3.1 Green	2.1.3.1 Green

FY 2013 Performance Goal Progress Summary

The Earth Science Subcommittee of the NASA Advisory Committee determined in September 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal.

A study combined data from NASA's SeaWinds scatterometer and the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) to provide the first documented changes in the three-dimensional infrastructure of several of the world's largest cities, from 1999 to 2009. It documented large increases in urban areas, with differing patterns of expansion upward and outward in different regions. Changes in East Asian cities were dominated by increases in the number and height of tall buildings, whereas changes in Indian cities reflected outward building, increasing the overall area covered by the city.

FY 2013 also included studies reporting significant changes in the phenology, or the timing of periodic plant and animal life cycle events, and seasonality of ecosystems, their biota, and the environmental factors influencing phenology. These studies indicate that global satellite data records are becoming sufficiently long to detect and analyze changes and trends and also that variations in climate are becoming large enough to have measurable effects on plants, animals, and ecosystems. Phenology is a first order control on carbon and energy budgets. The remote sensing observations of phenological events are becoming more useful in studies of global change. Below are some of the studies released during this reporting period:

- Researchers compared measurements from the recent High-Performance Instrumented Airborne Platform for Environmental Research (HIAPER) Pole-to-Pole Observations (HIPPO) large-scale aircraft campaign with airborne observations made 50 years earlier during the International Geophysical Year. The results show a large increase in the annual fluctuation of carbon dioxide concentrations in northern regions above 45 degrees latitude. Their study reported that fossil fuel, wildfire, and ocean fluxes of carbon dioxide contribute only a few percent to the seasonal carbon dioxide cycle in the Northern Hemisphere. They concluded that ecological changes in boreal and temperate forests are driving increases in summertime uptake of carbon dioxide. Based on the seasonal exchange observed over 50 years, the growing season uptake of carbon dioxide increased by 40 to 60 percent, whereas the dormant season release of carbon dioxide increased by only 20 to 50 percent.
- A paper summarized the ecological consequences of sea ice decline for marine phytoplankton, food webs, and animals, as well as the adjacent terrestrial plants and animals. Complex interrelationships within Arctic ecosystems are expected to change as a consequence of sea ice loss, with a wide variety of effects on populations, productivity, and biogeochemical dynamics.
- A study reported on increasing river alkalinization in the eastern United States as a consequence of acid deposition and accelerated chemical weathering. Large amounts of inorganic carbon (calcium carbonate) are being transported through these river systems and may need to be taken into account in regional carbon budgets.

- Researchers reported that they examined samples taken from the middle-lower troposphere during the 2010 Genesis and Rapid Intensification Processes (GRIP) campaign and found a significant amount of microorganisms. The researchers took the samples before, during, and after two tropical hurricanes and found that about 20 percent of the total micrometer-sized particles were viable bacteria cells. This suggests that bacteria represent an important and underestimated fraction of micrometer-sized atmospheric aerosols. They also noted that hurricanes aerosolize large amounts of new cells from different bacterial groups.

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Multiple Programs

FY 2015 ES-15-3: Demonstrate planned progress in detecting and predicting changes in Earth's ecological and chemical cycles, including land cover, biodiversity, and the global carbon cycle.

FY 2014 ES-14-6: Demonstrate planned progress in detecting and predicting changes in Earth's ecological and chemical cycles, including land cover, biodiversity, and the global carbon cycle.

FY 2013 ES-13-5: Demonstrate planned progress in quantifying, understanding and predicting changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES03 Green	9ES10 Green	10ES07 Green	ES-11-7 Green	ES-12-6 Green	ES-13-5 Green

Multi-year Performance Goal

FY 2015 and FY 2014 2.2.4: Demonstrate progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.

FY 2013 2.1.4.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.4: "Quantify the key reservoirs and fluxes in the global water cycle and assess water cycle change and water quality.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.1.4.1 Green	2.1.4.1 Green	2.1.4.1 Green

FY 2013 Performance Goal Progress Summary

The availability and quantity of water is vital to life on Earth and helps tie together Earth's lands, oceans, and atmosphere into an integrated physical system. The Earth Science Subcommittee of the NASA Advisory Committee determined in September 2013 that NASA remained on track in its FY 2013 performance supporting achievement of this performance goal, as demonstrated below.

The NASA Energy and Water cycle Study (NEWS) compiled a satellite-based energy and water cycle climatology, including monthly, continental, and oceanic averages of Earth's radiation balance, as well as precipitation, evaporation, and water vapor. The accompanying uncertainty evaluation adds valuable information for application of this data. It is helping to guide future satellite technology decisions and helping to improve climate model predictions using advanced diagnostics. These integrated water and energy satellite studies also have provided insights to the mechanisms and severity of mid-western U.S. floods and droughts, which will help mitigate future damage caused by these extremes. NEWS initiated a new science team and innovative integration projects focused on the role of clouds in the climate system and the origins and dynamics of the U.S. mid-western drought in 2012.

A study using data from the NASA GRACE mission found that large parts of the arid Middle East lost freshwater reserves rapidly during the past decade. In this study, scientists used GRACE observations to evaluate freshwater storage trends in the north-central Middle East, including portions of the Tigris and Euphrates river basins and western Iran, from January 2003 to December 2009. GRACE data showed an alarming decrease in total water storage during the course of the study period. Scientists used additional remote-sensing information and output from land surface models to identify that groundwater losses were the major source of this trend.

Narrow bands of strong atmospheric water vapor transport, referred to as atmospheric rivers, are responsible for the majority of wintertime extreme precipitation/flood events in the west coast of North America, with important contributions to the seasonal water balance. A series of studies were conducted to understand the impacts of atmospheric rivers on various components of the water cycle and the connection between atmospheric river activity and large-scale conditions of the climate system.

The SMAP Applications Program serves as an example for other NASA missions for successfully expanding their focus to include user communities' needs in the early phases of mission development. NASA has initiated a program of Early Adopters to promote application research in the pre-launch stages of the mission in order to provide a better understanding of how SMAP data products can be scaled and integrated into organizations' policy, business, and management activities. These efforts will expand the use of the data after launch and increase the societal benefit of the mission.

The Airborne Microwave Observatory Subcanopy and Subsurface (AirMOSS) mission observed nine North American study sites to produce the first-ever high-resolution (100 meter) maps of root-zone soil moisture profile to help determine the overall carbon exchange between plants and the atmosphere. Root-zone soil moisture impacts carbon uptake because water availability to plant roots is a prerequisite for

activating photosynthesis. These root-zone soil moisture maps are being generated for a wide variety of biomes, including boreal and temperate forests, arid shrub lands, croplands, woody savannahs, and the tropical rainforest. AirMOSS successfully flew over 100 flights, for a total of over 400 flight hours through August 2013, with more extensive science campaigns executed in the remainder of 2013 and planned for 2014 and 2015.

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Multiple Programs

FY 2015 ES-15-4: Demonstrate planned progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.

FY 2014 ES-14-7: Demonstrate planned progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.

FY 2013 ES-13-7: Demonstrate planned progress in quantifying the key reservoirs and fluxes in the global water cycle and assessing water cycle change and water quality. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES05 Green	9ES13 Green	10ES09 Green	ES-11-9 Green	ES-12-8 Green	ES-13-7 Green

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth System Science Pathfinder

FY 2015 ES-15-5: Complete Aquarius mission success criteria.

Does not trend to FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth Systematic Missions

FY 2015 ES-15-6: Complete Soil Moisture Active Passive (SMAP) mission success criteria.

Does not trend to FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 2.2.5: Demonstrate progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.

FY 2013 2.1.5.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.5: "Improve understanding of the roles of the ocean, atmosphere, land and ice in the climate system and improve predictive capability for its future evolution.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.1.5.1 Green	2.1.5.1 Green	2.1.5.1 Green

FY 2013 Performance Goal Progress Summary

The Earth Science Subcommittee of the NASA Advisory Committee determined in September 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

Researchers used data from the Aquarius/SAC-D mission to study the drop in sea surface salinity (SSS) in the Gulf of Mexico due to the record 2011 flooding of the Mississippi river. The researchers observed low SSS values associated with the spreading of the river plume from June to August (one to three months after peak river discharge). By October (five months after maximum discharge), SSS began to recede and became unidentifiable from satellite observations (which included ocean color data). At this

time, changes to SSS values along the coasts were likely due to a shift in the prevailing wind pattern from southerly/southeasterly that occurs during spring/summer to northerly/northeasterly during fall/winter. The response could additionally be associated with wind-driven mixing that weakened the low salinity signal at the ocean surface. Read more about this finding.

Numerous efforts were made in the past year that resulted in improved predictive capacity and improved modeling of the ocean, land, atmosphere, and ice system. These efforts involved increasing model complexity and interactivity, as NASA focused on developing its Earth system modeling capabilities. For example, researchers improved the NASA Goddard Institute for Space Studies Model E so it can now produce a more representative Madden-Julian Oscillation (MJO). MJO is the biggest driver of intraseasonal variability in the tropical atmosphere. It does not have a regular circulation pattern, making reliable models like Model E critical to prediction. Researchers also have improved Model E simulation of the stratospheric Quasi-Biennial Oscillation, a layer of winds at Earth's lower stratosphere that are alternately easterly and westerly, reversing direction about every 13 months. Changes to the model have also improved its representation of ocean processes. In addition, the NASA Ocean Biology Model was coupled in to Model E, allowing an investigation of differences in the simulation of ocean biology caused by the two different ocean models that are incorporated into Model E.

For the fourth year, Operation IceBridge deployed its multi-instrument aircraft to Antarctica in October through November 2012 and to the Arctic in March through May 2013. During the campaigns, NASA's flying laboratories (a DC-8 in Antarctica and a P-3B in the Arctic) used laser altimetry to profile surface elevations, ice-penetrating radar to measure ice thickness and map sub-glacial bedrock, and gravimetry to measure the depth and shape of water beneath ice shelves. These campaigns allowed scientists to add to growing time series of data and to survey new areas of the ice sheet. All IceBridge data is being made publicly available through the archive established at the National Snow and Ice Data Center.

A study released in 2013 has helped resolve differences in estimates of how fast glaciers are disappearing and contributing to sea level rise. The study combined conventional ground observations with data from NASA's GRACE satellites and ICESat to estimate ice loss from the Greenland and Antarctic ice sheets from 2003 to 2009. The ocean rose 0.03 inches (0.7 millimeters) per year, or about 29 percent of the total observed global sea level rise. Researchers perform on-site measurements of glacier mass changes along a line from a glacier's summit to its edge, or the flowline. The study shows that this method exceeds the losses determined from satellites, suggesting that the method needs to be revised toward smaller magnitudes of mass loss.

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Multiple Programs

FY 2015 ES-15-7: Demonstrate planned progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.

FY 2014 ES-14-9: Demonstrate planned progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.

FY 2013 ES-13-9: Demonstrate planned progress in understanding the roles of ocean, atmosphere, land, and ice in the climate system and improving predictive capability for future evolution. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES07 Green	9ES15 Green	10ES11 Green	ES-11-11 Green	ES-12-10 Green	ES-13-9 Green

Multi-year Performance Goal

FY 2015 and FY 2014 2.2.6: Demonstrate progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.

FY 2013 2.1.6.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.6: "Characterize the dynamics of Earth's surface and interior and form the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.1.6.1 Green	2.1.6.1 Green	2.1.6.1 Green

FY 2013 Performance Goal Progress Summary

The Earth Science Subcommittee of the NASA Advisory Committee determined in September 2013 that NASA remained on track in its annual performance supporting achievement of this performance goal. Below are examples of the science progress reported in FY 2013.

A NASA funded study used the global gravity measurements from the GRACE satellites to explain the global mean sea level drop of almost a quarter of an inch (5 millimeters), which occurred between the beginning of 2010 and mid-2011. This reduction occurred in the context of a multi-decade rate of rise of 0.1 inches (three millimeters) per year inferred from the 18-year record of sea level change observed by satellite altimeters. Using a combination of satellite and in situ data, the study showed that the decline in sea level was caused by movement of water from oceans to land, primarily Australia, northern South America, and Southeast Asia. This temporary shift is closely related to the transition from El Niño conditions in 2009 and 2010 to a strong La Niña in 2010 and 2011, which affected precipitation patterns worldwide. The phenomena were first observed for the 1998 El Niño, but complete explanation of the process involved in the mass redistribution was obtained with the GRACE measurements. The

measurements show a recovery to the original mass distribution by 2012, with a continuation of sea level rise.

NASA's Next-Generation Satellite Laser Ranging (NGSLR) system successfully tracked a majority of the International Laser Ranging Service (ILRS) satellites, with very robust daylight tracking of the high-altitude Global Navigation Satellite System satellites. In July 2013, NGSLR completed a five-week collocation tracking campaign with the operational Mobile Laser Ranging Stations (MOBLAS)-7, demonstrating excellent measurement stability and performance. NGSLR demonstrated key aspects of this system at the prototype Space Geodesy site at NASA Goddard Space Flight Center. NASA led a multiagency effort to place Laser Retroreflector Arrays (LRA) on future Global Positioning System (GPS) satellites beginning with GPS III Space Vehicle (SV)-9, with a signed agreement by the leadership of NASA and the U.S. Air Force.

In April 2013, NASA began test flights of the airborne Unmanned Aerial Vehicle Synthetic Aperture Radar (UAVSAR) aboard a Global Hawk. This development, made possible through integration of NASA's remote sensing and global precise navigation technologies, will permit applications of active remote sensing of targets that are too localized, and need to be observed too frequently over short time scales, to be monitored from orbit. This is particularly true of local natural hazards such as moderate earthquakes, volcanic eruptions, landslides, floods, and fires. In June, NASA completed electrical and communication checks of the L-band radar and began engineering demonstration flights in October. The scientific data provided by the UAVSAR will complement what can be provided from current spaceborne SARs.

NASA, the National Science Foundation, and several universities are close to making the Real-Time Earthquake Analysis for Disaster, or READI Mitigation Network, operational. The technology, which uses over 500 Global Navigation Satellite System receivers in the western United States, provides high-precision, second-by-second measurements of ground displacements. The technology offers advances in natural hazard mitigation over inertial devices, which detect vibrations, offering near-real-time identification and characterization of tsunamigenic earthquakes.

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Multiple Programs

FY 2015 ES-15-8: Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.

FY 2014 ES-14-11: Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.

FY 2013 ES-13-11: Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior and forming the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES11 Green	9ES17 Green	10ES13 Green	ES-11-15 Green	ES-12-14 Green	ES-13-11 Green

Multi-year Performance Goal

FY 2015 and FY 2014 2.2.7: Further the use of Earth system science research to inform decisions and provide benefits to society.

FY 2013 2.1.7.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.1.7: "Enable the broad use of Earth system science observations and results in decision-making activities for societal benefits.")

Performance Trending:

FY 2011	FY 2012	FY 2013
2.1.7.1 Green	2.1.7.1 Green	2.1.7.1 Green

FY 2013 Performance Goal Progress Summary

Through the Applied Sciences Program, NASA enables innovative and practical uses of its Earth science data by businesses, government agencies, and nonprofits to support and inform their decisions. During FY 2013, these projects and decision-making efforts helped improve quality of life and strengthen the economy.

NASA supported the response to 16 disasters, providing data to respond to Hurricane Sandy, Typhoon Bopha, wildfires, and others. For Hurricane Sandy, NASA used new capabilities on the Suomi NPP satellite and rapidly developed innovative power-outage assessments, aiding the Federal Emergency Management Agency, the U.S. Army Corps of Engineers, and others to allocate resources and distribute relief supplies. NASA also completed the transfer of one of its airborne research sensors to the U.S. Forest Service for operational use in wildfire management.

An effort with the California Department of Water Resources delivered improved methods to forecast water supply from snow cover data obtained by NASA satellites. A project with the Inter-American Tropical Tuna Commission delivered a satellite-based tool to map habitats of tuna and other marine resources for effective stock assessments and management actions. NASA continued a new, phased approach to conduct applications projects, initially supporting a set of feasibility studies and then selecting a subset to pursue as in-depth projects. The Applied Sciences Program selected nine drought-related feasibility studies for in-depth development, and the program will select subsets of projects related to wildfires and disasters early in FY 2014.

In the SERVIR program (managed jointly with U.S. Agency for International Development), NASA expanded novel uses of Tropical Rainfall Measurement Mission (TRMM) data to support the abilities of ministries in East Africa to assess streamflow, better anticipate flooding, support farming practices, and enable early warnings of agricultural production shortages. In FY 2013, over 350 young professionals participated in 75 DEVELOP projects to pursue Earth science applications projects on real-world issues facing state and local governments, setting a record for DEVELOP participation. NASA also completed dozens of applications projects focused on the Gulf of Mexico region, including projects addressing water management, disasters, and public health issues.

NASA continued efforts to engage the applications community in early stage planning for upcoming satellite missions. For example, four future water-related satellites—SMAP, GPM (which launched on February 27, 2014), GRACE-FO, and SWOT—held a joint mission workshop to explore how the combination of data products can help in hydrological applications at global and local scales. The event focused on collaborative opportunities among these missions (and existing ones) to increase the usefulness of the missions to the broad user community, especially for topics like drought, flooding, water management, and extreme events.

NASA continued its efforts to build capabilities in analyzing and quantifying benefits of Earth observations. Through the Applied Sciences Program, NASA published a primer on techniques to measure socioeconomic impacts of Earth science. NASA produced an award-winning app and published a book and e-book on images of Earth from NASA Earth science satellites. It also received the 2013 award for Excellence in Policy Implementation and Knowledge Transfer from Geospatial World Media.

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Applied Sciences

FY 2015 ES-15-9: Advance at least 25 percent of decision-support projects one Applications Readiness Level.

FY 2014 ES-14-12: Advance at least 25 percent of decision-support projects one Applications Readiness Level.

FY 2013 ES-13-12: Advance at least 25 percent of decision-support projects one Applications Readiness Level. The Applications Readiness Level is a nine-stage index for tracking the advancement of an Earth science applications project along a continuum from initial concept through development and transition to operational use.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES12 Green	9ES18 Green	10ES14 Green	ES-11-16 Green	ES-12-15 Green	ES-13-12 Green

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth Science Multi-Mission Operations

FY 2015 ES-15-10: Maintain a high level of customer satisfaction, as measured by exceeding the most recently available Federal government average rating of the Customer Satisfaction Index.

FY 2014 ES-14-14: Maintain a high level of customer satisfaction, as measured by exceeding the most recently available Federal government average rating of the Customer Satisfaction Index.

FY 2013 ES-13-14: Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES14 Green	9ES20 Green	10ES16 Green	ES-11-18 Green	ES-12-17 Green	ES-13-14 Green

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Multi-year Performance Goal

FY 2015 and FY 2014 2.2.8: By December 2017, launch at least five missions in support of Strategic Objective 2.2.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth Systematic Missions

FY 2015 ES-15-13: Complete the Ice, Cloud, and Land Elevation Satellite (ICESat)-2 Spacecraft Readiness for Integration Review.

FY 2014 ES-14-10: Deliver the Ice, Cloud, and Land Elevation Satellite (ICESat)-2 flight lasers.

FY 2013 ES-13-10: Complete the Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2) Critical Design Review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	9ES16 Yellow	10ES12 Green	ES-11-14 Yellow	ES-12-13 Yellow	ES-13-10 Yellow

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth Systematic Missions

FY 2015 ES-15-15: Complete the Gravity Recovery and Climate Experiment (GRACE) Follow-On mission Critical Design Review (CDR).

FY 2014 ES-14-18: Complete the Gravity Recovery and Climate Experiment (GRACE) Follow-On mission Preliminary Design Review (PDR).

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth System Science Pathfinder

Does not trend to FY 2015.

FY 2014 ES-14-2: Complete the Orbiting Carbon Observatory (OCO)-2 observatory testing.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES04 Yellow	9ES2 Green	10ES22 Green	ES-11-3 Yellow	ES-12-2 Green	None

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth Systematic Missions

Does not trend to FY 2015.

FY 2014 ES-14-4: Launch the Global Precipitation Measurement (GPM) mission.

FY 2013 ES-13-4: Complete the Global Precipitation Measurement (GPM) mission observatory environmental testing.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES06 Yellow	9ES8 Yellow	10ES06 Green	ES-11-6 Yellow	ES-12-5 Yellow	ES-13-4 Green

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth System Science Pathfinder

FY 2015 ES-15-11: Complete the Cyclone Global Navigation Satellite System (CYGNSS) Critical Design Review (CDR).

FY 2014 ES-14-5: Complete Cyclone Global Navigation Satellite System (CYGNSS/EV-2) Preliminary Design Review (PDR).

FY 2013 ES-13-2: Complete the Earth Venture-2 (EV-2) Mission Definition Review (MDR).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	ES-13-2 Green

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth Systematic Missions

FY 2015 ES-15-12: Launch the Soil Moisture Active Passive (SMAP) mission.

FY 2014 ES-14-8: Complete Soil Moisture Active Passive (SMAP) Instrument Thermal Vacuum Test.

FY 2013 ES-13-8: Complete the Soil Moisture Active Passive (SMAP) Systems Integration Review (SIR).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	9ES14 Green	10ES10 Yellow	ES-11-10 Yellow	ES-12-9 Green	ES-13-8 Green

Annual Performance Indicator

Contributing Theme: Earth Science
Contributing Program(s): Earth Systematic Missions

FY 2015 ES-15-14: Complete the Surface Water and Ocean Topography (SWOT) mission Ka-band Radar Interferometer (KaRIn) antenna Preliminary Design Review (PDR).

Does not trend to FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

STRATEGIC OBJECTIVE 2.3: OPTIMIZE AGENCY TECHNOLOGY INVESTMENTS, FOSTER OPEN INNOVATION, AND FACILITATE TECHNOLOGY INFUSION, ENSURING THE GREATEST NATIONAL BENEFIT.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established FY 2014 next steps for Strategic Objective 2.3 that set the foundation for achieving this objective in three key areas.

Optimize Agency Technology Investments

- Update and expand the NASA Space Technology Roadmaps to create the new "NASA Technology Roadmaps," which will document a wide range of needed aeronautics, space and information technologies and development pathways for the next 20 years.
- Update the NASA Strategic Space Technology Investment Plan and expand it to create the Strategic Technology Investment Plan, an actionable plan that lays out the strategy for developing technologies essential to the pursuit of all NASA's missions and achievement of national goals. This plan will provide the prioritization and guiding principles of investment for the technologies identified in the roadmaps.
- Make Technology Portfolio Tracking System (TechPort) information available to the public, supporting the Open Data Initiative and increasing public access to information about federally funded research. Internally, NASA will use TechPort to document, track, analyze, and manage the portfolio of technology investments across the Agency. TechPort allows users to search technology information, learn about technologies being developed by NASA, conduct analysis, generate reports, and identify prospective technology development partners.
- Complete the Emerging Space Investment Index.

Foster Open Innovation

- Complete the NASA Policy Directive for Agency challenges, prizes, and crowdsourcing.
- Establish at least two new "open innovation" mechanisms that leverage external support for the Asteroid Grand Challenge.
- Develop a Web site where all NASA open innovation opportunities (prizes, crowdsourcing, citizen science) are posted to make it easier for people to understand how NASA engages the public in problem solving and how they can get involved.
- Advocate for and provide technical assistance to organizations within NASA holding challenges for the first time. This includes supported capacity and skill development within NASA for conducting these types of activities.

Facilitate Technology Transfer

- Develop and implement two innovative methods for technology licensing.
- Develop plans and operational models for implementing the new licensing methods.

- Develop infrastructure and explore the legal parameters of new licensing methods.
- Finalize legal review of the licensing methods.

Strategic Objective Leader: Jim Adams, Deputy Chief Technologist, Office of the Chief Technologist

Multi-year Performance Goal

FY 2015 and FY 2014 2.3.1: Implement the five-year Strategic Plan to improve the ability to transfer NASA-developed technologies.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
3.4.1.2 Green	3.4.1.2 Green	None

Annual Performance Indicator

Contributing Theme: Space Technologies
Contributing Program(s): Partnership Development and Strategic Integration

FY 2015 ST-15-7: Each Center will engage with at least one university business school for technology marketing assessments and encouragement of technology application.

FY 2014 ST-14-8: The Agency will develop and implement two innovative methods for technology licensing.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8IPP02 Green	9IPP2 Green	None	ST-11-14 Green	ST-12-14 Green	None

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Multi-year Performance Goal

FY 2015 and FY 2014 2.3.2: Implement a process that enables the Agency to define and lead the Agency Grand Challenge.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Space Technologies
Contributing Program(s): Partnership Development and Strategic Integration

FY 2015 ST-15-8: Establish at least two new "open innovation" mechanisms that leverage external support for the Asteroid Grand Challenge.

FY 2014 ST-14-9: Establish at least two new "open innovation" mechanisms that leverage external support for the Asteroid Grand Challenge.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

STRATEGIC OBJECTIVE 2.4: ADVANCE THE NATION'S STEM EDUCATION AND WORKFORCE PIPELINE BY WORKING COLLABORATIVELY WITH OTHER AGENCIES TO ENGAGE STUDENTS, TEACHERS, AND FACULTY IN NASA'S MISSIONS AND UNIQUE ASSETS.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses the strategy for achieving this strategic objective.

As part of performance planning, NASA has established next steps for Strategic Objective 2.4, near-term milestones that set the foundation for achievement of this objective. For FY 2014, NASA will:

- Create a portfolio of projects that is in alignment with the five-year science, technology, engineering, and mathematics (STEM) education Strategic Plan issued by the Office of Science and Technology Policy Committee on STEM Education;
- Align the new portfolio with the Office of Education's updated organizational structure;
- Develop the One Stop Shopping Initiative longitudinal study to establish a baseline for NASA's STEM education and workforce impact; and
- Enhance reporting capabilities for the Office of Education's data collection suite of applications.

Strategic Objective Leader: Dr. Roosevelt Johnson, Deputy Associate Administrator for Education, Office of Education

Multi-year Performance Goal

FY 2015 and FY 2014 2.4.1: Assure that students participating in NASA higher education projects are representative of the diversity of the Nation.

FY 2013 5.1.2.1: Assure that students participating in NASA higher education projects are representative of the diversity of the Nation, based on student enrollment data maintained by the U.S. Department of Education's National Center for Education Statistics.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.1.2.1 Green	5.1.2.1 Yellow	5.1.2.1 White

FY 2013 Performance Goal Progress Summary

NASA's performance in diversity is examined across gender, ethnicity, race, and disability status. NASA Education continually sets aggressive targets for itself, with the ultimate goal of exceeding the national STEM enrollment averages for these communities in Education's participant base. However, for FY 2013, NASA rated this performance goal, and the supporting annual performance indicator, ED-13-1, White.

NASA did not achieve its goal of exceeding national STEM enrollment averages in two of the three diversity areas of focus. NASA Education reported the following percentages for significant direct student awards in the demographic areas highlighted under this performance goal, compared with national averages:

- 12 percent racially underrepresented students compared to a national average of eight percent and 13 percent ethnically underrepresented students compared against a national average of 8 percent;
- 29 percent female students compared to a national average of 39 percent; and
- One percent students with disabilities compared to a national average of 11 percent.

While NASA Education surpassed the national STEM enrollment averages for participants from underrepresented and underserved ethnic and racial communities, it still seeks improvement regarding the participation of women and individuals with disabilities in NASA's higher education programs. Continuing resolutions passed for FY 2012 and FY 2013 affected the Office of Education programmatic activities that would have addressed these ambitious diversity targets. A continuing resolution provides limited funding to sustain government operations until Congress enacts Appropriations legislation for the fiscal year. The FY 2012 and FY 2013 continuing resolutions resulted in the untimely allocation of funds, hindering Education's ability to implement many of the planned programmatic changes within the calendar year, including implementation of the new Education portfolio structure. As a result, student participation reported for FY 2013 remained relatively constant with participation reported in FY 2012. Note: NASA Education reports on prior year data. Data being reported here in support of FY 2013 Performance Plan ratings covers the Federal FY 2012 calendar year and correlates with the 2011 to 2012 academic calendar.

Moving forward, NASA will maintain this performance goal and its associated annual performance indicator (with changes to incorporate veterans in FY 2015 and students across all institutional levels and types) in FY 2014, thereby allowing NASA Education time to implement targeted strategic programming and accountability initiatives. As a part of the new portfolio in FY 2014, NASA Education will strategically fund the Achieving Competence in Computing, Engineering, and Space Science (ACCESS) project. ACCESS is focused primarily on providing opportunities for students with disabilities in NASA's internship, fellowship, and scholarship experiences. If this plan can be executed as scheduled the impact should be evident in FY 2016 reporting. In FY 2013, NASA Education fully implemented its performance measurement system, which provides enhanced data collection capabilities that will enable it to more efficiently and accurately report on its progress in this national area of focus.

Annual Performance Indicator

Contributing Theme: Education
Contributing Program(s): Multiple Programs

FY 2015 ED-15-1: Provide significant, direct student awards in higher education to (1) students across all institutional levels and types (as defined by the U.S. Department of Education); (2) racially or ethnically underrepresented students, (3) women, (4) persons with disabilities, and (5) veterans at percentages that meet or exceed the national percentages for these populations, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the five categories.

FY 2014 ED-14-1: Provide significant, direct student awards in higher education to (1) students across all institutional levels and types (as defined by the U.S. Department of Education); (2) racially or ethnically underrepresented students, (3) women, and (4) persons with disabilities at percentages that meet or exceed the national percentages for these populations, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the four categories.

Contributing Theme: Education
Contributing Program(s): STEM Education and Accountability

FY 2013 ED-13-1: Provide significant, direct student awards in higher education to (1) racially or ethnically underrepresented students, (2) women, and (3) persons with disabilities at percentages that meet or exceed the national STEM enrollment percentages for these populations, as determined by the most recent publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the three categories.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ED03 Green	9ED3 Red	10ED03 Yellow	ED-11-1 Yellow	ED-12-1 Red	ED-13-1 White

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Multi-year Performance Goal

FY 2015 and FY 2014 2.4.2: Continue to support STEM educators through the delivery of NASA education content and engagement in educator professional development opportunities.

FY 2013 6.1.1.1: Assure the availability and accessibility of NASA's online curricular support and resources to improve educators' STEM content knowledge and enhance student interest and proficiency in STEM disciplines.

Performance Trending:

FY 2011	FY 2012	FY 2013
6.1.1.1 Green	6.1.1.1 Green	6.1.1.1 White

FY 2013 Performance Goal Progress Summary

NASA Education embraces the use of technology and follows best practices in its use and delivery of online innovative learning tools to ensure that NASA's unique education content is accessible at all times and available in numerous formats. NASA fell short of achieving its ambitious target of 1,000 online teaching tools. By the end of FY 2013, NASA Education offered approximately 600 online teaching

tools, available to the public and directly marketed to primary, secondary, and informal educators and higher education faculty to assist in their professional development and enhance their teaching experiences with learners. This was the first year NASA Education reported on this performance goal. NASA has since determined that it did not have an accurate baseline from which to determine a realistic target and the target of 1,000 online teaching tools was not feasible based on historical data. Additionally, NASA determined that this performance goal's focus was too narrow, emphasizing the quantity rather than the quality and outcome of NASA Education's efforts to enhance its online resources for educators and students. Moving forward, NASA has canceled this performance goal and performance indicator by rating them White and will replace them with more outcome-focused measures that are inclusive of all methods employed by NASA to deliver educator professional development and the subsequent use of NASA Education tools by educator participants.

Annual Performance Indicator

Contributing Theme: Education
Contributing Program(s): Multiple Programs

FY 2015 ED-15-2: 250,000 educators participate in NASA-supported professional development, research, and internships that use NASA-unique STEM content.

FY 2014 ED-14-6: 250,000 educators participate in NASA-supported professional development, research, and internships that use NASA-unique STEM content.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 2.4.3: Assure that the institutions NASA engages with represent the diversity of institution types and levels in the Nation as defined by the U.S. Department of Education.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Education
Contributing Program(s): Multiple Programs

FY 2015 ED-15-3: Provide funding to institutions of higher education across all institutional categories and types (as defined by the U.S. Department of Education) that meet or exceed the national percentages for these institutional types and category levels, as determined by the most recent, publicly available data from the U.S. Department of Education.

Does not trend to FY 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 2.4.4: Continue to provide opportunities for learners to engage in STEM education through NASA-unique content provided to informal education institutions designed to inspire and educate the public.

FY 2013 6.4.1.1: Continue to provide opportunities for learners to engage in STEM education through NASA content provided to informal education institutions.

Performance Trending:

FY 2011	FY 2012	FY 2013
6.4.1.1 Green	6.4.1.1 Green	6.4.1.1 Green

FY 2013 Performance Goal Progress Summary

NASA Education exceeded its performance target of strategic partnerships in no fewer than 30 states and U.S. territories and/or the District of Columbia with its maintenance of the NASA Museum Alliance and other strategic STEM education partnerships. NASA Education engaged with partners in 50 states and/or U.S. territories and/or the District of Columbia. This was as of the end of FY 2012, when the last full cycle of data was available. NASA Education receives its performance data on the school calendar year cycle instead of the Federal government fiscal year.

NASA Education currently supports a diverse portfolio of programs, including competitive programs for science museums and planetariums that will enhance programs related to space exploration, aeronautics, space science, Earth science, or microgravity. These partnerships, maintained through the NASA Museum Alliance, result in strategic collaboration between STEM formal and informal education providers at science centers, planetariums, museums, aquariums, zoos, nature centers, parks, and observatories, NASA, and Challenger visitor centers, which promote STEM literacy and awareness of NASA's Mission.

Annual Performance Indicator

Contributing Theme: Education
Contributing Program(s): Multiple Programs

FY 2015 ED-15-4: Maintain the NASA Museum Alliance and/or other STEM education strategic partnerships in no fewer than 30 states, U.S. territories, and/or the District of Columbia.

FY 2014 ED-14-5: Maintain the NASA Museum Alliance and/or other STEM education strategic partnerships in no fewer than 30 states, U.S. territories, and/or the District of Columbia.

Contributing Theme: Education
Contributing Program(s): STEM Education and Accountability

FY 2013 ED-13-5: Maintain the NASA Museum Alliance and/or other STEM Education strategic partnerships in no fewer than 30 states, U.S. Territories and/or the District of Columbia.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ED06 Green	9ED11 Green	10ED10 Green	ED-11-9 Green	ED-12-9 Green	ED-13-5 Green

Multi-year Performance Goal

FY 2015 and FY 2014 2.4.5: Continue to provide opportunities for learners to engage in STEM education engagement activities that capitalize on NASA-unique assets and content.

FY 2013 6.1.2.2: Focus resources, including content, facilities, and personnel, to improve the impact of NASA's STEM education efforts on areas of greatest national need, as identified in the 2011 NASA Education Design Team report, ensuring that NASA-unique assets are leveraged when conducting direct-service student activities.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	6.1.2.2 Green

FY 2013 Performance Goal Progress Summary

NASA Education conducted approximately 1,800 individual K-12 indirect and direct interactive events in FY 2012, when the last full cycle of data was available. These events leveraged NASA-unique resources, personnel, content, and facilities, and reached 1,372,387 learners worldwide. Interactive events included: experiential learning opportunities for youth at NASA Centers or events at NASA Education partner facilities with NASA content; design challenges with live mentoring from NASA scientists and engineers; professional development opportunities for the Nation's K-12 STEM educators; and other opportunities.

Note: NASA Education receives its performance data on the school calendar year cycle instead of the Federal government fiscal year.

Annual Performance Indicator

Contributing Theme: Education
Contributing Program(s): Multiple Programs

FY 2015 ED-15-5: 600,000 elementary and secondary students participate in NASA STEM engagement activities.

FY 2014 ED-14-8: One million elementary and secondary students participate in NASA STEM engagement activities.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Strategic Goal 3: Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure.

STRATEGIC OBJECTIVE 3.1: ATTRACT AND ADVANCE A HIGHLY SKILLED, COMPETENT, AND DIVERSE WORKFORCE, CULTIVATE AN INNOVATIVE WORK ENVIRONMENT, AND PROVIDE THE FACILITIES, TOOLS, AND SERVICES NEEDED TO CONDUCT NASA'S MISSIONS.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses how the Agency will achieve this strategic objective. This includes creating and maintaining a diverse, productive, and motivated workforce, providing critical infrastructure and institutional capabilities, and being responsible stewards of the assets that support the Agency's workforce and mission requirements.

NASA has established next steps for Strategic Objective 3.1 as part of the Agency's performance planning, near-term milestones that set the foundation for achieving this objective. For FY 2014, NASA will:

- Continue targeted outreach and recruitment efforts;
- Emphasize work–life balance;
- Promote professional growth through education;
- Promote awareness of diversity and inclusion principles; and
- Use innovative approaches to provide business and administrative capabilities required to achieve NASA's Mission.

Strategic Objective Leader: Richard Keegan, Associate Administrator, Mission Support Directorate

Multi-year Performance Goal

FY 2015 and FY 2014 3.1.1: Define and build diverse workforce skills and competencies needed for the Agency's technology development and deep space exploration.

FY 2013 5.1.1.1: Define and build diverse workforce skills and competencies needed for the Agency's technology development and deep space exploration.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.1.1.1 Green	5.1.1.1 Green	5.1.1.1 Green

FY 2013 Performance Goal Progress Summary

NASA is working to create an innovative workplace where important Agency work can be conducted anywhere and anytime by putting information, data, and tools at the fingertips of those individuals who need it. In FY 2013, NASA conducted the Virtual Executive Summit (VES), which demonstrated that relevant Agency communications, collaboration, and learning could be effectively delivered in a distributed environment that engages employees both virtually and onsite. VES was built on the FY 2012 human capital framework, which was designed to create a workforce culture that thrives on and cultivates innovation. This innovative approach to learning exposed senior leaders to alternative learning environments, enhancing their capabilities and skills in working virtually, and saved the Agency approximately $750,000 in travel and program costs.

NASA sustained its Innovation Index at previous fiscal years levels (77.2 percent in FY 2013 compared to 77.6 percent in FY 2012), as determined through three innovation-related questions in the Agency's annual Employee Viewpoint Survey. Through the survey, NASA's employees expressed their opinions about their workplace environment and opportunities. Sustaining the Innovation Index was particularly significant because NASA could not issue cash performance awards in FY 2013 due to budget constraints.

Visit http://nasapeople.nasa.gov/ for more information.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-1: Sustain NASA's FY 2014 Innovation Score, as measured by the Innovation-related questions of the Employee Viewpoint Survey (EVS), by taking actions such as refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.

FY 2014 AMO-14-1: Sustain FY 2013 Innovation Score, as measured by the Innovation-related questions of the Employee Viewpoint Survey (EVS), by taking actions such as refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.

FY 2013 AMO-13-1: Sustain NASA's Innovation Score, as measured by the innovation-related questions in the Employee Viewpoint Survey (EVS), by taking actions like refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10WF06 White	AMO-11-1 Yellow	AMO-12-1 Green	AMO-13-1 Green

Multi-year Performance Goal

FY 2015 and FY 2014 3.1.2: Advance a workplace environment that affords equal employment opportunities (EEO) to all employees and takes proactive diversity and inclusion efforts.

FY 2013 5.1.1.5: Advance a workplace environment that affords Equal Employment Opportunities (EEO) to all employees and takes proactive diversity and inclusion efforts.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.1.1.5 Green	5.1.1.5 Green	5.1.1.5 Green

FY 2013 Performance Goal Progress Summary

NASA continued advancing equal employment opportunity and diversity and inclusion (D&I) through its Model EEO Agency Plan and its D&I Plan, respectively. These plans lay out specific strategies and actions to proactively prevent discrimination and harassment, effectively manage the Agency's EEO complaints process, increase racial, ethnic, gender, and other forms of diversity in the NASA workforce, and enhance the inclusiveness of the Agency's work environments. During FY 2013, NASA:

- Issued or was on target to issue appropriate policy and guidelines as needed (i.e., EEO complaints processing, Reasonable Accommodations procedures, Anti-Harassment/Anti-Bullying).
- Maintained functionality of the Anti-Harassment Program, used alternate dispute resolution in EEO, provided training and technical assistance (including one-on-one coaching under the Conflict Management Program), and conducted an internal compliance under the Functional Review Program.
- Issued D&I guidance on the use of employee resource groups and is on target to issue guidance on gender transitioning in FY 2014.
- Conducted five D&I technical assistance visits to Centers (exceeding the goal of two), helping them constructively address workforce challenges, such as enhancing employee engagement, increasing trust in leadership, and strengthening open communications.
- Continued to analyze the annual Employee Viewpoint Survey results.
- Worked on deploying a follow-on D&I survey to the 2010 Assessment Survey. During the fourth quarter of FY 2013, NASA tested the survey and prepared it for deployment in the second quarter FY 2014. These efforts will help NASA evaluate and address the remaining D&I challenges, as well as help NASA maintain its reputation as an employer of choice.

Visit NASA's Office of Diversity and Equal Opportunity Web site at http://odeo.hq.nasa.gov/.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-2: Sustain three programs and processes designed to proactively prevent discrimination, as outlined in the Model EEO Agency Plan.

FY 2014 AMO-14-2: Assess, evaluate, and report the success of the NASA Model EEO Agency Plans FY 2008 to FY 2013.

FY 2013 AMO-13-2: Sustain five programs and processes designed to proactively prevent discrimination, as outlined in the Model EEO Agency Plan.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10WF01 Green	AMO-11-7 Yellow	AMO-12-7 Green	AMO-13-2 Green

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-3: Assess, evaluate, and report the overall progress and effectiveness of the NASA Diversity and Inclusion Strategic Implementation Plan FY 2012 to FY 2015.

FY 2014 AMO-14-3: Evaluate overall progress and effectiveness of the Agency Diversity and Inclusion Strategic Implementation Plan to date, in preparation for its completion in fiscal year in FY 2015.

FY 2013 AMO-13-3: Implement an Agency Diversity and Inclusion (D&I) Strategic Plan aligned with the Government-wide D&I Strategic Plan.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10WF02 Green	AMO-11-8 Green	AMO-12-8 Green	AMO-13-3 Green

Multi-year Performance Goal

FY 2015 and FY 2014 3.1.3: Promote equal opportunity compliance and encourage best practices among NASA grant recipient institutions.

FY 2013 6.1.3.1: Promote equal opportunity compliance and encourage best practices among NASA grant recipient institutions.

Performance Trending:

FY 2011	FY 2012	FY 2013
6.1.3.1 Green	6.1.3.1 Green	6.1.3.1 Green

FY 2013 Performance Goal Progress Summary

NASA promotes equal opportunity (EO) compliance and encourages best practices among NASA grant recipient institutions through the Agency's onsite civil rights compliance reviews (at least two per year), compliance reports with specific recommendations for strengthening existing compliance and/or addressing specific compliance issues, and dissemination of promising practices of the institutions reviewed. NASA greatly enhanced dissemination of compliance requirements and promising practices for EO through the launch of the MissionSTEM Web site in November 2012, which allows NASA to reach more of the grantee population. This includes administrators, faculty, and students in NASA-funded science, technology, engineering, and math (STEM) programs. The site continues to evolve, with new content such as video series on the values of diversity and inclusion for STEM, and "featured promising practices" of various institutions.

Visit NASA's Office of Diversity and Equal Opportunity Web site at http://odeo.hq.nasa.gov/.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-4: Continue to broaden the scope of civil rights technical assistance to NASA grantees through the MissionSTEM Web site, focused on grantee civil rights requirements and promising practices for grantee compliance and diversity and inclusion.

FY 2014 AMO-14-10: Broaden the scope of civil rights technical assistance to NASA grantees through the MissionSTEM Web site on grantee civil rights requirements and promising practices for grantee compliance and diversity and inclusion.

FY 2013 AMO-13-11: Provide equal opportunity (EO) assessment and technical assistance, or on-site compliance assessment on-location, at a minimum of two STEM or STEM-related programs that receive NASA funding.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10WF11 Green	AMO-11-19 Green	AMO-12-19 Green	AMO-13-11 Green

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-5: Provide a civil rights compliance assessment at a minimum of two STEM or STEM-related programs that receive NASA funding.

FY 2014 AMO-14-11: Provide a civil rights compliance assessment at a minimum of two STEM or STEM-related programs that receive NASA funding.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 3.1.4: Between 2012 and 2016, support the demolition and elimination of obsolete and unneeded facilities.

FY 2013 5.2.3.1: Between 2012 and 2016, eliminate obsolete and unneeded facilities and support the elimination of facilities that will not be needed after Space Shuttle retirement.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.2.3.1 Green	5.2.3.1 Green	5.2.3.1 Green

FY 2013 Performance Goal Progress Summary

NASA identifies facilities for the demolition program through special studies, which determine if the facility is required for current or future missions. Facilities that are no longer needed are included in a five-year demolition plan that sets project schedules based on last need (both mission and date), annual

costs avoided if the facility is demolished, potential liability, and project execution factors. Facilities included in the five-year plan are occasionally adjusted due to consultation with states on historic properties, changes in operational schedules, environmental remediation, funding profiles, local market forces, and the value of recycled materials. NASA used its FY 2013 Demolition Program funding to demolish five facilities: one at Glenn Research Center, two at Stennis Space Center, and two at Kennedy Space Center.

Find out more about NASA's Office of Strategic Infrastructure at http://osi.hq.nasa.gov/.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 COF-15-1: Initiate the demolition or disposal of five facilities or structures during 2015 to reduce the Agency's footprint.

FY 2014 COF-14-1: Initiate the demolition or disposal of five facilities or structures during 2014 to reduce the Agency's footprint.

Contributing Theme: Construction of Facilities
Contributing Program(s): Institutional CoF

FY 2013 COF-13-1: Initiate the demolition or disposal of five facilities or structures during 2013 to reduce the Agency's footprint.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	COF-11-1 Green	COF-12-1 Green	COF-13-1 Green

Multi-year Performance Goal

FY 2015 and FY 2014 3.1.5: Manage coordination of NASA's international and interagency activities in conjunction with the NASA mission directorates.

FY 2013 5.5.2.1: Continue and improve coordination of NASA's international and interagency agreement activities.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.5.2.1 Green	5.5.2.1 Green	5.5.2.1 Green

FY 2013 Performance Goal Progress Summary

The NASA Office of International and Interagency Relations (OIIR) managed the development of new and ongoing international and interagency activities, maintaining a continuous dialogue with key NASA officials and NASA's international and interagency partners on their requirements. During FY 2013, OIIR:

- Tracked and managed a database of NASA's cooperative agreements with international partners, developed the international chapter for the NASA Office of General Council (OGC) Space Act Agreement Guide, and coordinated with the Department of State for international agreements requiring Circular 175 review.
- Led the Agency-wide meetings of Interagency Partnership Liaisons to coordinate and share information on NASA interagency partnership activities.
- In coordination with OGC, issued modifications to NASA procedures to enhance centralized tracking and coordination of NASA classified interagency agreements.
- Concluded over 100 agreements with over 16 countries, approximately 50 international agreements for Earth and space science cooperation, a framework agreement with Italy, 20 aeronautics research agreements and 25 lunar sample loan agreements. Highlights of agreement activities this fiscal year include: a first agreement with Saudi Arabia for a flight mission (UV-LED); the first two agreements with the Mexico in NASA's International Internship pilot program and another for ballooning cooperation; over 200 interagency space act agreements; over 20 new NASA J-1 Visiting Research Program agreements to sponsor over 40 foreign research scholars under NASA's J-1 visa program; landmark agreements with Department of Defense (DoD) organizations for the release of bolide (or atmospheric fireball events) data; the incorporation of centimeter-accuracy positioning technology on GPS satellites; and DoD support for astronauts in the post-Space Shuttle era.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-6: Revise the NASA export control training module to update and strengthen the content to reflect changes in regulations and to respond to audit findings.

FY 2014 AMO-14-26: Revise the NASA export control training module to update and strengthen the content to reflect changes in regulations and to respond to audit findings.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-7: Negotiate and conclude international and interagency agreements with foreign and domestic partners in support of NASA missions.

FY 2014 AMO-14-9: Negotiate and conclude international and interagency agreements with foreign and domestic partners in support of NASA missions.

FY 2013 AMO-13-10: Implement improved management of existing agreements by incorporating Office of International and Interagency Relations (OIIR)-led interagency agreements into the Agency agreements database (i.e., the Space Act Agreement Maker).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	AMO-11-18 Green	AMO-12-18 Green	AMO-13-10 Green

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Multi-year Performance Goal

FY 2015 and FY 2014 3.1.6: Achieve savings for the Agency through acquisition reforms.

FY 2013 5.2.4.1: Achieve savings for the Agency through acquisition reforms.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	5.2.4.1 Green

FY 2013 Performance Goal Progress Summary

NASA achieved at least $10 million in cost savings/cost avoidance through strategic sourcing and contracting efficiencies in FY 2013. This was achieved through a number of activities including the

Enterprise License Management Team, the Stennis Space Center Multiple Award Construction Contract, as well as a number of other procurement efforts.

In addition, the Assistant Administrator for Procurement continued to actively work with the Center Procurement Officers and the Federal Strategic Sourcing Leadership Council to identify strategic sourcing initiatives and to increase contract efficiencies through reduced transaction costs in NASA procurements. NASA Centers looked closely at contract types (increasing use of lower risk contract types such as Firm Fixed Price), reducing the number of task orders and increasing the core work under Indefinite Delivery, Indefinite Quantity contracts and reducing the number of incremental funding actions on all contracts.

Visit NASA's Office of Procurement Web site at http://www.hq.nasa.gov/office/procurement/.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-8: Achieve savings through increased use of both Federal-level and Agency-level strategic sourcing vehicles.

FY 2014 AMO-14-30: Achieve savings through increased use of both Federal-level and Agency-level strategic sourcing vehicles.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-9: Achieve savings through increased contract efficiencies and reduced transaction costs in NASA procurements.

FY 2014 AMO-14-8: Achieve savings through increased contract efficiencies and reduced transaction costs in NASA procurements.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 3.1.7: Ensure that NASA continues progress towards implementing statutory or Executive Order targets and goals reflected in its annual Sustainability Plan.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-10: Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) by 30 percent from 2003 baseline under 42 U.S.C. 8253.

FY 2014 AMO-14-20: Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) by 27 percent from 2003 baseline under 42 U.S.C. 8253.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-11: Attain 15 percent sustainable building inventory by 2015.

FY 2014 AMO-14-21: Attain 14 percent sustainable building inventory by 2014.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-12: Ensure that at least 7.5 percent of electricity is generated from renewable energy sources.

FY 2014 AMO-14-22: Ensure that at least 7.5 percent of electricity is generated from renewable energy sources.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 3.1.8: Enhance reach and effectiveness of programs and projects that engage the public.

FY 2013 6.4.2.1: Use current and emerging communications technologies to reach increasingly broad audiences.

Performance Trending:

FY 2011	FY 2012	FY 2013
6.4.2.1 Green	6.4.2.1 Green	6.4.2.1 Green

FY 2013 Performance Goal Progress Summary

Throughout FY 2013, NASA continued to expand the use of social media tools, adding new platforms and tools such as Reddit Ask Me Anything and Instagram. The Agency continuously tracked numbers for tools and social events, and this year NASA became the most followed Federal agency on Twitter, closing in on the five million follower mark. NASA also had the largest Instagram and Foursquare following in government and was second in government on Facebook and Google+.

In February 2013, NASA began participating in the Federal Digital Analytics Program, which uses Google Analytics to continuously measure traffic to numerous Federal Web sites. Google Analytics collects a variety of data, including visits to the sites, page views, file downloads and sources of traffic. Trend analysis will begin midway through FY 2014, after a year's worth of data has been collected. More than 50 NASA Web sites have joined the program, allowing the Agency the broadest view it has ever had of its Web presence.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-13: Use current and emerging communications technologies, platforms, and methods to reach increasingly broad and diverse audiences.

FY 2014 AMO-14-13: Use current and emerging communications technologies to reach increasingly broad audiences.

FY 2013 AMO-13-13: Evaluate for effectiveness social media tools the Agency uses to expand public outreach.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	AMO-11-21 Green	AMO-12-21 Green	AMO-13-13 Green

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-14: Develop a set of metrics by which to assess the reach and effectiveness of activities in the communications portfolio.

FY 2014 AMO-14-28: Assess the use of NASA content by completing the portfolio of communications activities being built through the Communications Coordinating Council governance process.

FY 2013 AMO-13-14: Decrease the Freedom of Information (FOIA) backlog of requests by 10 percent.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	AMO-11-22 Green	AMO-12-22 Green	AMO-13-14 Green

Multi-year Performance Goal

FY 2015 and FY 2014 3.1.9: Manage coordination of advisory committees' (NASA Advisory Committee and Aerospace Safety Advisory Panel) recommendations to the NASA Administrator.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2015 AMO-15-15: Provide NASA responses to advisory committees' recommendations made formally to the NASA Administrator.

FY 2014 AMO-14-27: Provide NASA responses to advisory committees' recommendations made formally to the NASA Administrator.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

STRATEGIC OBJECTIVE 3.2: ENSURE THE AVAILABILITY AND CONTINUED ADVANCEMENT OF STRATEGIC, TECHNICAL, AND PROGRAMMATIC CAPABILITIES TO SUSTAIN NASA'S MISSION.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses how the Agency will achieve this strategic objective, including providing access to space.

NASA has established FY 2014 next steps for Strategic Objective 3.2 as part of the Agency's performance planning, near-term milestones that set the foundation for achieving this objective.

Space Communications and Navigation

- Maintain all networks at a minimum of 95 percent proficiency.
- Continue development of enabling technology.
- Continue development of international standards.
- Maintain civil space leadership in spectrum.

21st Century Space Launch Complex

- Continue to establish and develop partnerships with government and commercial entities requiring ground processing, launch, recovery, and other services.
- Complete environmental mitigation projects at Kennedy Space Center (KSC).
- Complete development of systems to support small-class vehicle customers at KSC.
- Begin range telemetry systems upgrades at KSC.

Launch Service Providers

- Conduct Program Implementation Review in May 2014.

Rocket Propulsion Test

- Maintain civil space leadership in rocket propulsion testing.

Strategic Objective Leader: Greg Williams, Deputy Associate Administrator for Policy and Plans, Human Exploration and Operations Mission Directorate

Multi-year Performance Goal

FY 2015 and FY 2014 3.2.1: Review the current state of the NASA test capabilities, known test requirements and test requests, and revise the Master Plan as needed.

FY 2013 5.3.1.1: Review the current state of the NASA test capabilities, known test requirements and test requests, and revise the Master Plan as needed.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.3.1.1 Green	5.3.1.1 Green	5.3.1.1 Green

FY 2013 Performance Goal Progress Summary

NASA remained on target to achieve this performance goal. In FY 2013, NASA's Rocket Propulsion Test (RPT) Program used an on-going process for capturing and documenting facility requirements. This process allowed the program to flex available test assets between inactive and active states to meet new or reduced test requirements. This philosophy has allowed the RPT member sites to increase the total number of tests by nearly 250 percent over the same FY 2012 period. In FY 2013, RPT facilities completed 349 tests for a total of 272,344 seconds of test time, with all but one test supporting engine hot fire testing.

NASA also initiated two separate activities to provide information on the current state of the propulsion test capabilities. The first activity reviewed the backlogged and deferred facility maintenance projects for all the facilities. NASA completed this activity in May 2013. The second project was an independent facility health assessment, which is scheduled for completion in January 2014.

NASA separated its RPT Master Plan into two documents: the Yearly Report and a traditional Master Plan, which will document strategic requirements and investments. The Yearly Report, which was submitted in the first quarter FY 2014, is a summary of the current and planned construction activities, supporting current test requirements, current test requirements, facility maintenance and modernization investments, and utilization schedules. NASA updated the utilization schedules to reflect the current activities and planned testing.

Annual Performance Indicator

Contributing Theme: Space and Flight Support
Contributing Program(s): Rocket Propulsion Test

FY 2015 SFS-15-2: Sustain 90 percent availability of test facilities to support NASA and other customers' planned test requirements.

FY 2014 SFS-14-1: Sustain 90 percent availability of test facilities to support NASA and other customers' planned test requirements.

FY 2013 SFS-13-1: Incorporate test capability modifications and known test requirements in the yearly Rocket Propulsion Test (RPT) Master Plan update.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	9SFS3 Yellow	10SFS09 Yellow	SFS-11-1 Green	SFS-12-1 Green	SFS-13-1 Green

Multi-year Performance Goal

FY 2015 and FY 2014 3.2.2: Complete Launch Services Program (LSP) objectives for all NASA-managed expendable launches.

FY 2013 5.4.1.1: Complete Launch Services Program (LSP) objectives for all NASA-managed expendable launches.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.4.1.1 Green	5.4.1.1 Green	5.4.1.1 Green

FY 2013 Performance Goal Progress Summary

NASA remained on target to achieve this performance goal by sustaining a 100 percent success rate through FY 2013. The NASA-managed expendable launches included the Tracking Data and Relay Satellite (TDRS)-K on January 30, 2013, from Cape Canaveral Air Force Station in Florida, the Landsat Data Continuity Mission (now called Landsat 8) on February 11 from Vandenberg Air Force Base in California, and the Interface Region Imaging Spectrograph (IRIS) mission on June 27 from Vandenberg.

Annual Performance Indicator

Contributing Theme: Space and Flight Support
Contributing Program(s): Launch Services

FY 2015 SFS-15-3: Sustain a 100 percent success rate with the successful launch of NASA managed expendable launches, as identified on the Launch Services Flight Planning Board manifest.

FY 2014 SFS-14-2: Sustain a 100 percent success rate with the successful launch of NASA managed expendable launches, as identified on the Launch Services Flight Planning Board manifest.

FY 2013 SFS-13-2: Sustain a 100 percent success rate with the successful launch of NASA managed expendable launches as identified on the Launch Services Flight Planning Board manifest.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10SFS11 Green	SFS-11-2 Yellow	SFS-12-2 Green	SFS-13-2 Green

Annual Performance Indicator

Contributing Theme: Space and Flight Support
Contributing Program(s): Launch Services

FY 2015 SFS-15-4: Complete acquisitions on time for NASA-managed expendable launches.

FY 2014 SFS-14-3: Complete acquisitions on time for NASA-managed expendable launches.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 3.2.3: By 2014, launch two functionally identical Tracking and Data Relay Satellite (TDRS) spacecraft in geosynchronous orbits to replenish the Tracking and Data Relay Satellite System (TDRSS) constellation.

FY 2013 5.4.3.1: By 2014, launch two functionally identical Tracking and Data Relay Satellite (TDRS) spacecraft in geosynchronous orbits to replenish the Tracking and Data Relay Satellite System (TDRSS) constellation.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.4.3.1 Green	5.4.3.1 Green	5.4.3.1 Green

FY 2013 Performance Goal Progress Summary

NASA launched the first new spacecraft of TDRSS, TDRS-K, on January 30, 2013, from Cape Canaveral Air Force Station in Florida. NASA also completed development of TDRS-L, which prepared it for its launch in January 2014.

Annual Performance Indicator

Contributing Theme: Space and Flight Support
Contributing Program(s): Space Communications and Navigation

FY 2015 SFS-15-5: Complete Tracking and Data Relay Satellite (TDRS)-L Initial Operational Capability (IOC).

FY 2014 SFS-14-4: Complete in-orbit check-out of Tracking and Data Relay Satellite (TDRS)-L spacecraft.

FY 2013 SFS-13-4: Complete TDRS L Pre-Ship Review.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	9SFS6 Green	10SFS07 Yellow	SFS-11-5 Green	SFS-12-5 Green	SFS-13-4 Green

Multi-year Performance Goal

FY 2015 and FY 2014 3.2.4: By FY 2016, replace or upgrade obsolete and unsustainable systems of the Tracking and Data Relay Satellite System (TDRSS) Ground Segment at the White Sands Complex (WSC).

FY 2013 5.4.3.2: By FY 2016, replace or upgrade obsolete and unsustainable systems of the TDRSS Ground Segment at the White Sands Complex (WSC).

Performance Trending:

FY 2011	FY 2012	FY 2013
5.4.3.2 Green	5.4.3.2 Green	5.4.3.2 Yellow

FY 2013 Performance Goal Progress Summary

The Space Network Ground Segment Sustainment (SGSS) project is responsible for refurbishing NASA's existing Space Network Ground Segment, including replacing or upgrading the TDRSS Ground Segment at the White Sands Complex in New Mexico. SGSS has seven distinct elements, which form the building blocks for the ground terminals. In FY 2013, each element underwent and passed its critical design review (CDR). NASA completed the technical part of the SGSS CDR in June 2013. The SGSS Standing Review Board split the CDR into two separate reviews. The Standing Review Board completed the SGSS system

technical portion of the CDR in the third quarter of FY 2013. The cost element of the SGSS CDR will be held at the Standing Review Board's discretion during the third quarter of FY 2014. As a result, NASA rated SFS-13-5 Yellow.

Performance Improvement Plan

The SGSS project conducted an in-depth evaluation of the contractor performance in early November 2013. As a result of this in-depth review, the SGSS contractor is conducting a re-plan of the SGSS project that includes significant changes to the contractor leadership team, a flattening of the organization and a thorough review of all contractor processes and procedures to insure a cost effective, efficient organization. The revised plan will be presented to NASA by mid February. NASA will conduct the cost element of the CDR in 2014. Concurrently, NASA is performing a complete review of all elements of the program to ensure that the most cost effective solution is identified, and NASA will continue to proceed with the modernization of the White Sands Complex facility.

Annual Performance Indicator

Contributing Theme: Space and Flight Support
Contributing Program(s): Space Communications and Navigation

FY 2015 SFS-15-6: Complete preparations for the Space Network Ground Segment Sustainment (SGSS) Systems Integration Review (SIR).

FY 2014 SFS-14-5: Make progress towards the Space Network Ground Segment Sustainment (SGSS) Systems Integration Review (SIR).

FY 2013 SFS-13-5: Complete Space Network Ground Segment Sustainment (SGSS) Critical Design Review (CDR).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10SFS08 Yellow	SFS-11-6 Green	SFS-12-6 Green	SFS-13-5 Yellow

Multi-year Performance Goal

FY 2015 and FY 2014 3.2.5: By FY 2018, replace aging Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).

FY 2013 5.4.3.3: By FY 2018, replace aging and obsolete Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).

Performance Trending:

FY 2011	FY 2012	FY 2013
5.4.3.3 Green	5.4.3.3 Green	5.4.3.3 Green

FY 2013 Performance Goal Progress Summary

The Deep Space Network is an international network of antennas that supports interplanetary spacecraft missions, space-based telescopes, and some selected Earth-orbiting science missions. To meet ongoing demand for deep space communication services, it is replacing its aging Deep Space Station (DSS) 70-meter antennas with a new generation of 34-meter antennas. NASA completed the structural development of the pedestal and antenna structure at Canberra in 2013. With the structure complete, NASA will focus on the development and delivery of the electronic systems.

DSS-35 will be a 34-meter beam waveguide (BWG) antenna. It will have the same basic performance parameters of the previous 34-meter High-Efficiency antenna, but the BWG design relocates sensitive electronics from the center of the main reflector to the pedestal equipment room and offers easier access for maintenance and modifications.

Annual Performance Indicator

Contributing Theme: Space and Flight Support
Contributing Program(s): Space Communications and Navigation

FY 2015 SFS-15-7: Complete the antenna structure at Canberra Deep Space Communications Complex (CDSCC) for Deep Space Station (DSS)-46.

FY 2014 SFS-14-6: Complete the radio frequency equipment installation at Canberra Deep Space Communications Complex (CDSCC) to support operations.

FY 2013 SFS-13-6: Complete antenna structure for DSS-35 at the CDSCC.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	SFS-11-7 Green	SFS-12-7 Green	SFS-13-6 Green

Multi-year Performance Goal

FY 2015 and FY 2014 3.2.6: Prioritize and complete launch and range complex modernization studies and projects to sustain government and commercial capabilities at the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS).

FY 2013 5.4.2.1: Prioritize and complete launch and range complex modernization studies and projects to sustain government and commercial capabilities at the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS).

Performance Trending:

FY 2011	FY 2012	FY 2013
5.4.2.1 Green	5.4.2.1 Green	5.4.2.1 Green

FY 2013 Performance Goal Progress Summary

NASA and the U.S. Air Force (USAF) continued developing modernization plans for the launch and range assets located at KSC and the Cape Canaveral Air Force Station. The Future State Definition study, a yearlong analysis conducted by KSC and USAF's 45th Space Wing, was completed and endorsed for potential implementation. The study results included recommendations to optimize range operations, maintenance and policy agreements to enable efficiency and affordability. Throughout FY 2013, NASA also continued to develop the 21st Century Space Launch Complex, including IT backbone upgrades, spaceport command and control systems development, and NASA–USAF Eastern Range upgrades.

Annual Performance Indicator

Contributing Theme: Space and Flight Support
Contributing Program(s): 21st Century Space Launch Complex

FY 2015 ESD-15-4: Complete extension of utilities to support the first horizontal take-off, horizontal landing commercial partner at the Shuttle Landing Facility (SLF, and complete upgrades to the range telemetry systems.

FY 2014 ESD-14-4: Complete environmental mitigation projects to support horizontal take-off, horizontal landing commercial partner at the Shuttle Landing Facility (SLF); complete development of the Deployable Launch System and Universal Propellant Servicing System to enable a small-class vehicle launch capability at Kennedy Space Center; and begin range telemetry systems upgrades.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 3.2.7: Ensure the strategic availability and maintenance of facilities that are necessary to meet the long-term needs and requirements of the Agency.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Strategic Capabilities Assets Program

FY 2015 SC-15-1: Achieve a minimum of 80 percent overall availability of Strategic Capabilities Assets Program (SCAP) portfolio of assets, which are necessary to meet the long-term needs and requirements of the Agency.

FY 2014 SC-14-1: Achieve a minimum of 80 percent overall availability of Strategic Capabilities Assets Program (SCAP) portfolio of assets, which are necessary to meet the long-term needs and requirements of the Agency.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

STRATEGIC OBJECTIVE 3.3: PROVIDE SECURE, EFFECTIVE, AND AFFORDABLE INFORMATION TECHNOLOGIES AND SERVICES THAT ENABLE NASA'S MISSION.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses how the Agency will achieve this strategic objective.

NASA has established next steps for Strategic Objective 3.3 as part of the Agency's performance planning, near-term milestones that set the foundation for achievement of this objective. For FY 2014, NASA will:

- Update and publish the Information Resources Management Strategic Plan;
- Mature NASA's IT governance and enterprise architecture; and
- Perform an organizational assessment for readiness.

NASA is updating the Agency's Information Resources Management Strategic Plan in alignment with the upcoming release of the 2014 NASA Strategic Plan. The update focuses on mission-enabling IT capabilities and service delivery, information security and privacy, and IT planning and governance. This strategic foundation will provide the NASA community with the direction to achieve NASA's Strategic Objective 3.3.

Additional supporting activities include maturing NASA's enterprise architecture process and optimizing NASA's service delivery strategy to ensure the Agency achieves an appropriate balance between cost-effectiveness and responsiveness for NASA's customers. A business technology consulting firm is performing an organizational assessment of the Office of the Chief Information Officer to evaluate NASA's readiness to meet these demanding challenges.

Strategic Objective Leader: Larry Sweet, Chief Information Officer

Multi-year Performance Goal

FY 2015 and FY 2014 3.3.1: Enhance NASA's information security posture through implementation of automated security and privacy tools and technologies.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency IT Services

FY 2015 AMO-15-16: Plan and implement security technology upgrades for the Security Operations Center (SOC).

FY 2014 AMO-14-17: Identify new tools and technologies needed to support automated security and privacy systems.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency IT Services

Does not trend to FY 2015.

FY 2014 AMO-14-19: Achieve 95 percent implementation of continuous monitoring cybersecurity capabilities.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency IT Services

Does not trend to FY 2015.

FY 2014 AMO-14-23: Achieve 50 percent implementation of strong authentication cybersecurity capabilities.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency IT Services

Does not trend to FY 2015.

FY 2014 AMO-14-24: Achieve 99 percent implementation of Trusted Internet Connection consolidation cybersecurity capabilities.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency IT Services

Does not trend to FY 2015.

FY 2014 AMO-14-25: Achieve 100 percent implementation of Trusted Internet Connection 2.0 cybersecurity capabilities.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

FY 2015 and FY 2014 3.3.2: Identify viable alternatives to support Federal and Agency mobility goals, supporting Work from Anywhere (WFA).

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency IT Services

FY 2015 AMO-15-17: Conduct requisite project management analyses required by NPR 7120.7 and obtain approval from appropriate governance boards.

FY 2014 AMO-14-18: Implement a Mobile Device Management (MDM) capability to support access to NASA email and calendaring services from government and personally owned mobile devices.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Multi-year Performance Goal

Does not trend to FY 2015.

FY 2014 3.3.3: Consolidate and centralize the management of information technology (IT) enterprise services for end user services, communications, and enterprise applications.

FY 2013 5.2.2.1: By 2014, consolidate and centralize the management of information technology (IT) enterprise services for end user services, communications, and enterprise applications.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.2.2.1 Green	5.2.2.1 Green	5.2.2.1 White

FY 2013 Performance Goal Progress Summary

NASA completed the activities contributing to this performance goal except for the establishment of the Web Services service office, which was deferred to FY 2014 due to budget constraints. As a result, NASA rated this performance goal White. NASA completed the enterprise contract transitions for enterprise IT services, including Communications, End User Services, Enterprise Applications, and Enterprise Service Desk, and their service offices have been chartered and are fully operational.

The award and transition of the WESTPRIME contract was completed in order to provide a consistent, capable, and agile cloud-based enterprise infrastructure. NASA deferred the chartering, staffing, and operations of the service office for Web Services to FY 2014. Resources within the Office of the Chief Information Officer will provide stop-gap support services for Web Services customers until FY 2014, when the Web Services service office becomes operational.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency IT Services

Does not trend to FY 2015.

FY 2014 AMO-14-29: Transition 150 Web applications to the cloud.

FY 2013 AMO-13-7: Achieve full operational capability (FOC) on the remaining service office that is part of the NASA Information Technology Infrastructure Integration Program (I3P).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10IT02 Green	AMO-11-12 Yellow	AMO-12-12 Green	AMO-13-7 White

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Multi-year Performance Goal

FY 2015 and FY 2014 3.3.4: By 2015, reduce the number of data centers to 22.

FY 2013 5.2.2.4: By 2015, reduce data center energy consumption by 30 percent.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.2.2.4 Green	5.2.2.4 Yellow	5.2.2.4 White

FY 2013 Performance Goal Progress Summary

NASA implemented power metering for 50 percent of its Core Data Center infrastructure and IT loads to date, a dependency for establishing an energy consumption baseline for NASA's data centers. Some centers have implemented partial power metering or have not completed implementation of metering due to funding constraints. Based on current plans for this performance goal and reductions in budget, NASA will not complete these activities in a timeframe to measure achievement of the energy consumption target.

In alignment with the Cross-Agency Priority Goal for Data Center Consolidation and the Federal Data Center Consolidation Initiative, NASA closed three data centers in FY 2013 as planned and a total of 24 data centers to date. NASA's end goal is to have 22 data centers, 11 of which will be Core Data Centers. In order to align NASA's future performance plan with Federal performance targets, NASA updated this performance goal to target a specific number of NASA data center consolidations to reduce energy consumption. The new multi-year performance goal is, "By 2015, reduce the number of data centers to 22."

NASA rated this performance goal White based on the combined factors of budget impacts and changes made to keep in line with Federal performance targets.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency IT Services

FY 2015 AMO-15-18: Maintain the FY 2015 schedule of ten data center consolidations contained in NASA Federal Data Center Consolidation Plan.

FY 2014 AMO-14-7: Maintain the FY 2014 schedule of five data center consolidations contained in NASA Federal Data Center Consolidation Plan.

FY 2013 AMO-13-8: Implement power metering in 100 percent of NASA data centers.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	AMO-11-15 Green	AMO-12-15 Green	AMO-13-8 White

STRATEGIC OBJECTIVE 3.4: ENSURE EFFECTIVE MANAGEMENT OF NASA PROGRAMS AND OPERATIONS TO COMPLETE THE MISSION SAFELY AND SUCCESSFULLY.

Strategies and Next Steps

NASA's 2014 Strategic Plan (available at http://www.nasa.gov/news/budget/index.html) discusses how the Agency will achieve this strategic objective. Due to its crosscutting nature, Strategic Objective 3.4 is led by NASA's three independent Technical Authorities (see below), who rotate the leader role annually.

NASA has established next steps for Strategic Objective 3.4 as part of the Agency's performance planning, near-term milestones that set the foundation for achievement of this objective. For FY 2014, NASA will:

- Continue to ensure effective management of Agency programs and operations to complete the mission safely and successfully. No adjustments to the strategy, budgets, performance measures, or organization are anticipated at this time.

Strategic Objective Leader: Terrence Wilcutt (for FY 2014), Chief, Office of Safety and Mission Assurance; Ralph Roe (for FY 2015), Chief Engineer; Richard Williams (for FY 2016), Chief Health and Medical Officer

Multi-year Performance Goal

FY 2015 and FY 2014 3.4.1: Assure the safety and health of NASA's activities and reduce damage to assets through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, quality assurance, and health and medical policies and procedures.

FY 2013 5.2.1.1: Through 2015, assure the safety and health of NASA's activities and reduce damage to assets through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, quality assurance and health and medical policies and procedures.

Performance Trending:

FY 2011	FY 2012	FY 2013
5.2.1.1 Green	5.2.1.1 Green	5.2.1.1 Green

FY 2013 Performance Goal Progress Summary

NASA assured the safety and health of NASA's activities and reduced the damage to assets throughout FY 2013. This was demonstrated by the following: no fatalities or permanent disabling injuries to the public from NASA activities; NASA's Total Case Rate and Lost Time Cast Rate was under the injury/illness goals established in the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative; and the non-mission failure damage costs ($0.82 million) were significantly below the five-year running average.

Visit NASA's Office of Safety and Mission Assurance Web site at http://www.hq.nasa.gov/office/codeq/.

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Safety and Mission Success

FY 2015 AMO-15-19: Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during FY 2015.

FY 2014 AMO-14-4: Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during FY 2014.

FY 2013 AMO-13-4: Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10SMS01 Green	AMO-11-9 Green	AMO-12-9 Green	AMO-13-4 Green

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Safety and Mission Success

FY 2015 AMO-15-20: Maintain a Total Case Rate and Lost Time Case Rate that meets or exceeds the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.

FY 2014 AMO-14-5: Maintain a Total Case Rate and Lost Time Case Rate that meets or exceeds the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.

FY 2013 AMO-13-5: Maintain a Total Case Rate and Lost Time Case Rate that meets the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	AMO-11-10 Red	AMO-12-10 Green	AMO-13-5 Green

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Safety and Mission Success

FY 2015 AMO-15-21: Reduce damage to NASA assets (excluding launched flight hardware) by two percent during FY 2015, based on a five-year running average (that also excludes launched flight hardware).

FY 2014 AMO-14-6: Reduce damage to NASA assets (excluding launched flight hardware) by two percent during FY 2014, based on a five-year running average (that also excludes launched flight hardware).

FY 2013 AMO-13-6: Reduce damage to NASA assets (excluding launched flight hardware) by two percent during FY 2013, based on a five-year running average (that also excludes launched flight hardware).

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	AMO-11-11 Red	AMO-12-11 Green	AMO-13-6 Green

Multi-year Performance Goal

FY 2015 and FY 2014 3.4.2: Implement the policies, procedures and oversight to continuously improve the probability of technical and programmatic mission success.

Does not trend to FY 2013.

Performance Trending:

FY 2011	FY 2012	FY 2013
None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Safety and Mission Success

FY 2015 AMO-15-22: Ensure 100 percent of Category 1 and 2 projects use Agency Safety and Mission Success policy, procedures and independent assessments focused on both technical and programmatic mission success.

FY 2014 AMO-14-15: Ensure 100 percent of Category 1 and 2 projects use Agency Safety and Mission Success policy, procedures and independent assessments focused on both technical and programmatic mission success.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Annual Performance Indicator

Contributing Theme: Agency Management and Operations
Contributing Program(s): Safety and Mission Success

FY 2015 AMO-15-23: Ensure that 100 percent of the engineering and programmatic workforce has access to the standards and knowledge base needed to maintain and build their skills.

FY 2014 AMO-14-16: Ensure that 100 percent of the engineering and programmatic workforce has access to the standards and knowledge base needed to maintain and build their skills.

Does not trend to FY 2013.

Performance Trending:

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	None

Retired FY 2013 Measures: Reported Performance

API ISS-13-5: Provide 100 percent of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) needed to support research.

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	10ISS08 Green	ISS-11-3 Green	ISS-12-4 Green	ISS-13-5 Green

API ISS-13-7: Deliver at least four physical sciences payloads for launch to ISS.

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AC01 Green	9AC1 Green	10AC01 Green	ERD-11-2 Green	ISS-12-8 Green	ISS-13-7 Green

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Performance Goal 2.1.1.2: By 2015, launch at least two missions in support of objective 2.1.1.

FY 2011	FY 2012	FY 2013
2.1.1.2 Green	2.1.1.2 Green	2.1.1.2 Green

The purpose of this performance goal is to launch satellites in support of objective 2.1.1, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. NASA's Earth Science program includes the design, development, and launch of a portfolio of new missions, along with the operation and provision of data from the existing fleet of Earth observing spacecraft. Launching missions in a timely way increases scientific capabilities and helps maintain data continuity. Once the satellites are operating on orbit, NASA uses these assets for scientific research and a range of Earth observing capabilities.

NASA launched the first satellite supporting this performance goal, Aquarius, in June 2011. During its three-year mission life, Aquarius will observe and model seasonal and year-to-year variations of sea-surface salinity and how these variations relate to changes in the water cycle and ocean circulation, thereby influencing climate. Aquarius will collect more sea surface salinity measurements than the entire 125-year historical record from ships and buoys.

The next mission, Orbiting Carbon Observatory (OCO)-2, is planned for launch no later than 2015, within the completion timeframe for this performance goal. OCO-2 will be NASA's first dedicated Earth remote sensing satellite to study atmospheric carbon dioxide from space. Data from OCO-2 will help scientists better understand the processes that regulate atmospheric carbon dioxide and its role in the carbon cycle.

Performance Goal 2.1.2.2: By 2015, launch at least two missions in support of objective 2.1.2.

FY 2011	FY 2012	FY 2013
2.1.2.2 Green	2.1.2.2 Green	2.1.2.2 Green

The purpose of this performance goal is to launch satellites in support of objective 2.1.2, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. NASA's Earth Science program includes the design, development, and launch of a portfolio of new missions, along with the operation and provision of data from the existing fleet of Earth observing spacecraft. Launching missions in a timely way increases scientific capabilities and helps maintain data continuity. Once the satellites are operating on orbit, NASA uses these assets for scientific research and a range of Earth observing capabilities.

NASA launched the first mission satisfying this performance goal, Suomi NPOESS Preparatory Project (NPP), in October 2011. Suomi NPP, a bridge between NASA's Earth Observing System satellites and the next-generation Joint Polar Satellite System, is collecting critical data to improve short-term weather forecasts and increase understanding of long-term climate change.

During FY 2013, NASA completed the environmental testing for the second mission, Global Precipitation Measurement (GPM) observatory. The GPM mission will advance the measurement of global precipitation, making possible high spatial resolution precipitation measurements. A joint mission with the Japanese Aerospace Exploration Agency (JAXA), GPM will provide the first opportunity to calibrate measurements of global precipitation (including the distribution, amount, rate, and associated heat released) across tropical, mid-latitude, and polar regions. GPM launched from Japan on February 27, 2014.

Performance Goal 2.1.3.2: By 2015, launch at least two missions in support of objective 2.1.3.

FY 2011	FY 2012	FY 2013
2.1.3.2 Green	2.1.3.2 Green	2.1.3.2 Green

The purpose of this performance goal is to launch satellites in support of objective 2.1.3, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. NASA's Earth Science program includes the design, development, and launch of a portfolio of new missions, along with the operation and provision of data from the existing fleet of Earth observing spacecraft. Launching missions in a timely way increases

scientific capabilities and helps maintain data continuity. Once the satellites are operating on orbit, NASA uses these assets for scientific research and a range of Earth observing capabilities.

NASA successfully launched the Landsat Data Continuity Mission, now named Landsat-8, on February 11, 2013. Landsat-8 will extend the record of multispectral, moderate resolution Landsat-quality data and will meet government operational and scientific requirements for observing land use and land change. New changes in land cover and use are having profound consequences for weather and climate change, ecosystem function and services, carbon cycling and sequestration, resource management, the national and global economy, human health, and society.

The second mission, OCO-2, is planned for launch no later than 2015, within the completion timeframe for the performance goal.

API ES-13-6: Launch the Landsat Data Continuity Mission (LDCM).

Contributing Theme: Earth Science
Contributing Program(s): Earth Systematic Missions

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	9ES11 Yellow	10ES08 Green	ES-11-8 Green	ES-12-7 Green	ES-13-6 Green

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Performance Goal 2.1.4.2: By 2015, launch at least two missions in support of objective 2.1.4.

FY 2011	FY 2012	FY 2013
2.1.4.2 Green	2.1.4.2 Green	2.1.4.2 Green

The purpose of this performance goal is to launch satellites in support of objective 2.1.4, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. NASA's Earth Science program includes the design, development, and launch of a portfolio of new missions, along with the operation and provision of data from the existing fleet of Earth observing spacecraft. Launching missions in a timely way increases scientific capabilities and helps maintain data continuity. Once the satellites are operating on orbit, NASA uses these assets for scientific research and a range of Earth observing capabilities.

NASA launched Aquarius in June 2011. NASA completed the GPM observatory environmental testing in July 2013, and GPM launched from Japan in February 2014. NASA also is developing another mission that would serve this performance goal, the Soil Moisture Active-Passive (SMAP) mission. SMAP is on schedule to launch in late 2014. NASA completed the SMAP Systems Integration Review on April 11, 2013, certifying that SMAP's systems were working together and could be integrated into the spacecraft bus for testing. The accuracy, resolution, and global coverage of SMAP soil moisture and freeze/thaw measurements will be unprecedented. The SMAP data, when assimilated into existing and updated Earth system science models, will lead to improved weather forecasts, flood and drought forecasts, and

predictions of agricultural productivity and climate change, as well as improved understanding of the sources and sinks of carbon.

Performance Goal 2.1.5.3: By 2015, launch at least three missions in support of objective 2.1.5.

FY 2011	FY 2012	FY 2013
2.1.5.3 Green	2.1.5.3 Green	2.1.5.3 Green

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.1.5, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. NASA's Earth Science program includes the design, development, and launch of a portfolio of new missions, along with the operation and provision of data from the existing fleet of Earth observing spacecraft. Launching missions in a timely way increases scientific capabilities and helps maintain data continuity. Once the satellites are operating on orbit, NASA uses these assets for scientific research and a range of Earth observing capabilities.

NASA launched Aquarius in June 2011 and Suomi NPP in October 2011, placing the Agency on track to complete the performance goal. The third mission, OCO-2, is planned for launch no later than 2015, within the completion timeframe for the goal.

NASA also has been working on the Ice, Cloud, and land Elevation Satellite (ICESat)-2, which will study ice-sheet thickness and changes (see Annual Performance Indicator ES-13-10 under Performance Goal 2.2.8). The project completed its formulation phase and entered development in FY 2013. NASA rated the annual performance indicator for this project Yellow because ICESat-2 cost and schedule performance showed sharp erosion in January 2013, as the project missed milestones and costs associated with the instrument increased. The project traced much of the substandard performance to optics design complexity, immature technical analysis, and insufficient planning for integration and testing. The project addressed these issues by replacing the instrument management team, adding new technical expertise and resources, and revamping the engineering and review processes. The new instrument management team has instituted a more detailed monthly review of all instrument subsystems. The team conducted an assessment of the cost, schedule, and technical aspects of the mission to develop an achievable plan to be presented at the mission Critical Design Review, which is now planned for February 2014. Successful completion of this review will give the project permission to proceed with final design and fabrication prior to the start of integration and testing of the spacecraft.

Performance Goal 2.1.6.2: By 2015, launch at least one mission in support of objective 2.1.6.

FY 2011	FY 2012	FY 2013
2.1.6.2 Green	2.1.6.2 Green	2.1.6.2 Green

The purpose of this performance goal is to launch satellites in support of objective 2.1.3, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. NASA's Earth Science program includes the design, development, and launch of a portfolio of new missions, along with the operation and provision of data from the existing fleet of Earth observing spacecraft. Launching missions in a timely way increases scientific capabilities and helps maintain data continuity. Once the satellites are operating on orbit, NASA uses these assets for scientific research and a range of Earth observing capabilities.

NASA successfully launched the Landsat Data Continuity Mission, now Landsat-8, on February 11, 2013. Landsat-8 will extend the record of multispectral, moderate resolution Landsat-quality data and will meet government operational and scientific requirements for observing land use and land change. New changes in land cover and use are having profound consequences for weather and climate change, ecosystem function and services, carbon cycling and sequestration, resource management, the national and global economy, human health, and society.

API ES-13-6: Launch the Landsat Data Continuity Mission (LDCM).

Contributing Theme: Earth Science
Contributing Program(s): Earth Systematic Missions

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	9ES11 Yellow	10ES08 Green	ES-11-8 Green	ES-12-7 Green	ES-13-6 Green

API ES-13-13: Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.

Contributing Theme: Earth Science
Contributing Program(s): Earth Science Multi-Mission Operations

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ES13 Green	9ES19 Green	10ES15 Green	ES-11-17 Green	ES-12-16 Green	ES-13-13 Green

API HE-13-2: Achieve mission success criteria for the Solar Dynamics Observatory (SDO).

Contributing Theme: Heliophysics
Contributing Program(s): Living with a Star

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8HE06 Green	None	None	None	None	HE-13-2 Green

Performance Goal 2.2.1.2: By 2015, launch two missions in support of objective 2.2.1.

FY 2011	FY 2012	FY 2013
2.2.1.2 Green	2.2.1.2 Green	2.2.1.2 Green

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.2.1, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. The launch of these missions will provide not only critical new knowledge, but will also broaden the distribution and capabilities of observation posts that are needed to study the full range of Sun-solar system connections. This combination of new heliophysics knowledge and a well-supported constellation of operating missions can facilitate the path towards an operational capability to predict space weather.

NASA launched the first mission in support of this performance goal, the two-spacecraft Radiation Belt Storm Probes (RBSP), on August 30, 2012. Following on-orbit checkout, the mission was renamed the Van Allen Probes. The mission will observe the fundamental processes that energize and transport radiation belt electrons and ions in Earth's inner magnetosphere, the area in and around Earth's radiation belts. These observations will provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace.

NASA plans to launch the second mission, Magnetospheric Multiscale (MMS), by 2015. The MMS mission will use Earth's magnetosphere as a laboratory to study the microphysics of magnetic reconnection, a fundamental plasma-physical process that converts magnetic energy into heat and the kinetic energy of charged particles. In FY 2013, NASA integrated the payload to the first of the four satellites.

API HE-13-2: Achieve mission success criteria for the Solar Dynamics Observatory (SDO).

Contributing Theme: Heliophysics
Contributing Program(s): Living with a Star

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8HE06 Green	None	None	None	None	HE-13-2 Green

Performance Goal 2.2.2.2: By 2015, launch two missions in support of objective 2.2.2.

FY 2011	FY 2012	FY 2013
2.2.2.2 Green	2.2.2.2 Green	2.2.2.2 Green

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.2.2, as guided by *A Decadal Strategy for Solar and Space Physics*, pre-published by the National Academies in 2012. These missions will help scientists study the Sun, the heliosphere, and other planetary environments as an interconnected system. This is critical for understanding the implications for Earth, to predict and mitigate the hazards associated with exploration, and to understand the impact of the space environment for the habitability of other worlds.

NASA launched the first mission in support of this performance goal, the two-spacecraft Van Allen Probes (formerly RBSP), on August 30, 2012. The mission will observe the fundamental processes that energize and transport radiation belt electrons and ions in Earth's inner magnetosphere, the area in and around Earth's radiation belts. These observations will provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace.

NASA plans to launch the second mission, MMS, by 2015. The MMS mission will use Earth's magnetosphere as a laboratory to study the microphysics of magnetic reconnection, a fundamental plasma-physical process that converts magnetic energy into heat and the kinetic energy of charged particles. In FY 2013, NASA integrated the payload to the first of the four satellites.

Performance Goal 2.2.3.2: By 2017, launch at least two missions in support of objective 2.2.3.

FY 2011	FY 2012	FY 2013
2.2.3.2 Green	**2.2.3.2 Green**	**2.2.3.2 Green**

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.2.3, as guided by *A Decadal Strategy for Solar and Space Physics*, pre-published by the National Academies in 2012. These missions will help scientists study the Sun, the heliosphere, and other planetary environments as an interconnected system. This is critical for understanding the implications for Earth, to improve space weather predictions, and to predict and mitigate the hazards associated with exploration.

NASA launched the first mission in support of this performance goal, the two-spacecraft Van Allen Probes (formerly RBSP), on August 30, 2012. The mission will observe the fundamental processes that energize and transport radiation belt electrons and ions in Earth's inner magnetosphere, the area in and around Earth's radiation belts. These observations will provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace.

The second mission, Solar Orbiter, is on schedule for launch in 2017. SOC, a collaborative mission with the European Space Agency, will investigate the connections and the coupling between the Sun and the heliosphere, a huge bubble in space created by the solar wind that extends far beyond the solar system. In February 2013, the Solar Orbiter passed its Confirmation Review and in March, the mission entered development.

Performance Goal 2.3.1.2: By 2017, launch at least two missions in support of objective 2.3.1.

FY 2011	FY 2012	FY 2013
2.3.1.2 Green	2.3.1.2 Green	2.3.1.2 Green

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.3.1, as guided by *Vision and Voyages for Planetary Science in the Decade 2013-2022*, published by the National Academies in 2011.

NASA is on track to launch both the Origins Spectral Interpretation Resource Identification Security–Regolity Explorer (OSIRIS-REx) and the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSIGHT) mission in 2016.

OSIRIS-REx will collect and return a sample from near-Earth asteroid Bennu. The mission will provide information on how the planets formed in the early solar system and how life began. It also will provide better understanding of asteroids that could impact Earth. OSIRIS-REx will arrive at Bennu in 2018 and return a sample to Earth in 2023. In April 2013, OSIRIS-REx entered the development phase, when the spacecraft will be built, assembled, and tested in preparation for launch.

InSIGHT will land on Mars and study its deep interior. It will address one of the most fundamental issues of planetary and solar system science: understanding the processes that shaped the rocky planets of the inner solar system (including Earth) more than four billion years ago. In October 2012, InSIGHT entered the formulation phase, when the mission's requirements are set.

Performance Goal 2.3.2.2: By 2015, launch at least three missions in support of objective 2.3.2.

FY 2011	FY 2012	FY 2013
2.3.2.2 Green	2.3.2.2 Green	2.3.2.2 Green

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.3.2, as guided by *Vision and Voyages for Planetary Science in the Decade 2013-2022*, published by the National Academies in 2011. NASA has completed this performance goal by successfully launching the three planned missions.

Juno, launched successfully in August 2011, is on its way to Jupiter, will collect data on the solar system's beginnings by revealing the origin and evolution of the giant planet. The Gravity Recovery and Interior Laboratory (GRAIL), launched in September 2011, is in lunar orbit, making a high-resolution map of the Moon's gravitational field. The Lunar Atmosphere and Dust Environment Explorer (LADEE) launched on September 6, 2013, also is in orbit around the Moon, gathering detailed information about

the structure and composition of the thin lunar atmosphere and to determine if dust is being lofted into the lunar sky.

API PS-13-4: Launch the Lunar Atmosphere and Dust Environment Explorer (LADEE).

Contributing Theme: Planetary Science
Contributing Program(s): Lunar Quest

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	PS-12-6 Green	PS-13-4 Green

Performance Goal 2.3.3.2: By 2015, launch at least two missions in support of objective 2.3.3.

FY 2011	FY 2012	FY 2013
2.3.3.2 Green	2.3.3.2 Green	2.3.3.2 Green

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.3.3, as guided by *Vision and Voyages for Planetary Science in the Decade 2013-2022*, published by the National Academies in 2011.

NASA successfully launched the Mars Science Lander (MSL) in November 2011 and is collecting data to find out if Mars could have once harbored life. The Mars Atmosphere and Volatile Evolution (MAVEN) mission launched in November 2013 (FY 2014), completing this performance goal. MAVEN will explore Mars' upper atmosphere, ionosphere, and interactions with the Sun and solar wind.

API PS-13-9: Demonstrate planned progress in identifying and characterizing small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Contributing Theme: Planetary Science
Contributing Program(s): Multiple Programs

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8PS08 Green	9PS9 Green	10PS10 Green	PS-11-12 Green	PS-12-12 Green	PS-13-9 Green

Performance Goal 2.3.5.2: Return data for selection of destinations in order to lower risk for human space exploration beyond low Earth orbit.

FY 2011	FY 2012	FY 2013
2.3.5.2 Green	2.3.5.2 Green	2.3.5.2 Green

The routine processing and listing of accessible near-Earth asteroids on the NASA Near-Earth Object Observations (NEOO) Program Web site identifies and lists future observing opportunities for ground-based assets. These observing opportunities are used to obtain physical characterization information that could determine whether or not a particular near-Earth asteroid is suitable as a potential candidate as part of mission that would robotically bring the asteroid into lunar orbit where astronauts could explore it. Ground-based sensors can provide details concerning the size, configuration, rotation rate, and bulk composition of the near-Earth asteroid to help NASA mission planners and planetary scientists select the best targets. These opportunities are listed for optical and radar assets, which are used by the worldwide planetary astronomy community to perform physical characterization observations of these potentially accessible near-Earth asteroids.

The NEOO Program pursued additional risk reduction efforts in coordination with the Human Exploration and Operation Mission Directorate's Joint Robotic Precursor Activity, including:

- Increased funding for time on ground-based planetary radars at Goldstone, CA, and Arecibo, PR, which enables a five-fold increase in the number of near-Earth asteroids observed and characterized for precise orbit, size, and rotation information. An upgrade to the Goldstone radar has increased the resolution that can be imaged down to four meters.
- Extensive analyses to develop several design reference missions for near-Earth asteroid human exploration, including identification of additional investments required (i.e., concepts of operations, vehicle sizing, advanced propulsion) to expand the number of viable near-Earth asteroids to explore.
- Reactivation of the Wide-field Infrared Survey Explorer (WISE) spacecraft for a dedicated mission of NEO search and characterization called NEOWISE. The healthy spacecraft and low Earth orbit that it is currently in should allow another three years of useful data collection.

NEXT Ion Thruster Sets World Record For Electric Propulsion Life

While the Dawn spacecraft is using solar powered propulsion to visit the asteroids Vesta and Ceres, NASA has been developing the next generation of ion thrusters for future missions. NASA's Evolutionary Xenon Thruster (NEXT) project has developed a seven-kilowatt ion thruster that has demonstrated six times improvement in performance over Dawn's thruster. The NEXT ion thruster operated in a vacuum chamber for over five years, which means that the thruster processed over 815 kilograms of xenon propellant and can provide 31 million newton-seconds of total impulse to the spacecraft. With this demonstrated performance, NEXT enables more challenging science missions, including missions to multiple destinations requiring high levels of total impulse, such as extended tours of multi-asteroids, comets, and outer planets and moons.

An ion thruster produces small levels of thrust (compared to traditional chemical thrusters), but by operating for long periods it slowly accelerates the spacecraft to speeds not achievable with advanced chemical propulsion.

API PS-13-10: Demonstrate planned progress in characterizing potentially hazardous objects that are possible destinations for future human space exploration.

Contributing Theme: Planetary Science
Contributing Program(s): Multiple Programs

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	9AC16 Green	10AC17 Green	PS-11-13 Green	PS-12-13 Green	PS-13-10 Green

API AS-13-2: Achieve mission success criteria for the Fermi Gamma-ray Space Telescope.

Contributing Theme: Astrophysics
Contributing Program(s): Physics of the Cosmos

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AS02 Green	None	10AS04 Green	None	None	AS-13-2 Green

Performance Goal 2.4.2.2: Design and assemble the James Webb Space Telescope (JWST).

FY 2011	FY 2012	FY 2013
2.4.2.2 Yellow	2.4.2.2 Green	2.4.2.2 Green

NASA made significant progress on developing the Integrated Science Instrument Module (ISIM), one of three major elements that comprise JWST's flight system and what is called the main payload. Engineers integrated two of the four science instruments—the Mid-Infrared Instrument and the Fine Guidance Sensor—into ISIM, along with supporting electronics. ISIM was installed into the cryogenic vacuum chamber at Goddard Space Flight Center (GSFC) for testing and testing was initiated. The third science instrument, the Near Infrared Camera optical module, was delivered to GSFC in September. The fourth and last science instrument, the Near Infrared Spectrograph, completed cryogenic testing in Europe and was delivered to GSFC in September. NASA cryogenically tested critical flight structures, such as the wing sections of the primary mirror support structure, the Marshall Space Flight Center, and 15 of 18 flight primary mirrors were delivered to GSFC. After completing cryogenic upgrades to the large vacuum chamber at the Johnson Space Center, work on the associated cleanroom was begun and is on schedule. The Space Telescope Science Institute completed the design review of the software employed in managing all the data returned from the spacecraft to the operations center.

Performance Goal 2.4.2.3: Develop and operate an airborne infrared astrophysics observatory.

FY 2011	FY 2012	FY 2013
2.4.2.3 Green	2.4.2.3 Green	2.4.2.3 Green

NASA and the German Aerospace Center, Deutsches Zentrum fur Luft- und Raumfahrt (DLR), are developing the Stratospheric Observatory for Infrared Astronomy (SOFIA), an airborne observatory that will complement the Hubble, Spitzer, and Herschel space telescopes. NASA is on track to achieve SOFIA full operational capability in FY 2014.

On May 8, 2013, SOFIA's second-generation science instrument, the High-resolution Airborne Wideband Camera Plus (HAWC+), passed its Systems Requirements Review. When completed, the camera will allow the observatory to measure the structure and strength of magnetic fields in the interstellar medium, star forming regions, and the center of the Milky Way.

API AS-13-6: Achieve mission success criteria for the Kepler mission.

Contributing Theme: Astrophysics
Contributing Program(s): Exoplanet Exploration

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AS08 Green	9AS8 Green	None	None	None	AS-13-6 Green

API ERD-13-3: Test docking and anchoring techniques for asteroid missions using a prototype crew excursion vehicle, the Multi-Mission Space Exploration Vehicle (MMSEV), moving on an air bearing floor.

Contributing Theme: Exploration Research and Development
Contributing Program(s): Advanced Exploration Systems

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	ERD-13-3 Green

API ERD-13-4: Assess the feasibility of a Multi-Purpose Logistics Module (MPLM) based habitation module to support human deep-space missions.

Contributing Theme: Exploration Research and Development
Contributing Program(s): Advanced Exploration Systems

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	ERD-13-4 Green

Performance Goal 3.3.2.2: Develop technologies and mission concepts for demonstrating in-space cryogenic propellant storage and transfer making exploration and science missions more affordable and capable.

FY 2011	FY 2012	FY 2013
3.3.2.2 Green	3.3.2.2 Green	3.3.2.2 Green

NASA achieved this multi-year performance goal and continues to develop technologies and mission concepts for demonstrating in-space cryogenic propellant storage and transfer. The Cryogenic Propellant Storage and Transfer (CPST) project, continued the formulation phase of the NASA project life cycle during FY 2013. In September 2013, the CPST demonstration passed its System Requirements Review, which determined that the project was in line with NASA's strategic objectives, had properly formulated requirements, and a credible estimated budget and schedule. The project is on track to progress into preliminary design in FY 2014.

Performance Goal 3.4.1.1: Accelerate the development and adoption of NASA-funded technology through the establishment of cost-sharing partnerships.

FY 2011	FY 2012	FY 2013
3.4.1.1 Green	3.4.1.1 Green	3.4.1.1 Green

NASA took a number of steps to accelerate the development and adoption of NASA-funded technology through partnerships. The Agency initiated a study to evaluate the current Agency guidance, governance, and processes that support the development of partnership agreements. The results of the study will go to NASA's Executive Council, who will use them to decide how to enhance NASA's abilities to use partnerships to effectively support national and Agency strategic goals and priorities. The decision, in part, will improve processing time by ensuring that partnerships are not unduly delayed based on NASA's review and approval process. Additionally, many NASA Centers entered into formal agreements whereby the partners commit to explore opportunities. These agreements include scheduled technical interchanges that allow the technology collaboration potential to be more quickly identified and scoped up front. Following are some FY 2013 examples:

- At NASA Armstrong Flight Research Center (formerly Dryden Flight Research Center), the Space Technology Mission Directorate entered into a partnership with Masten Space Systems, Inc., to advance the maturity of technologies towards spaceflight readiness status. Specifically, the agreement will advance the technologies for "Deployable Rigid Adjustable Guided Final Landing Approach Pinions." Visit the Flight Opportunities Tech Portfolio for more information about this technology.
- Johnson Space Center (JSC) engaged in several partnerships with regional consortiums, including Greater Houston Partnership and Houston Technology Center (HTC), resulting in opportunities to market technologies to non-aerospace industries. HTC conducts Technology Connect events that enable JSC to present targeted technology transfer opportunities to entrepreneurs and technology developers.
- A new fiber-optic monitoring system developed through a Space Act Agreement between NASA JSC and Astro Technology, Inc., of Houston is now helping increase safety for workers and reduce the risk of leaks and spills on two oil platforms off the coast of West Africa.
- NASA's Kennedy Space Center (KSC) continued to streamline its processes for accelerating the development of partnerships. KSC began planning a Request for Information to provide an open call looking for potential collaborators for technology development partnerships. This call will be released in March 2014 and is expected to identify more partners, including non-traditional partners interested in assisting NASA KSC in helping to solve mission needs.

NASA also made progress on developing non-traditional partnerships with private-sector individuals and organizations.

- On June 18, 2013, NASA's Office of the Chief Technologist (OCT) announced the Asteroid Grand Challenge to "find all asteroid threats to human populations and know what to do about them" with the purpose of engaging in partnerships to generate public benefit.
- NASA announced several new prizes and crowdsourcing opportunities to obtain solutions and stimulate innovation from a broad public community rather than a specific, named group or individual. These included the Unmanned Aircraft Systems Centennial Challenge, ISS Food Intake Tracking, Robonaut vision, ISS longeron shadowing challenge, Non-Invasive Intercranial Pressure Measurement techniques, and Earth science Big Data Challenge. Together, these enable solvers to help NASA address tough problems.
- OCT's Emerging Space Office supported the Space Frontier Foundation in their annual New Space Business Plan Competition, engaged in a partnership with Sustainable Silicon Valley, supported the State of Hawaii's Pacific International Space Center for Exploration Systems program under NASA's Space Act Agreement, and in July 2013, completed the "Public-Private Partnerships for Space Capability Development" study conducted in collaboration with NASA's Office of Strategy Formulation.

API ST-13-6: Establish a total of twelve partnerships with U.S. industry, other U.S. agencies, or other entities to develop technology that supports NASA's missions or national interests.

Contributing Theme: Space Technologies
Contributing Program(s): Partnership Development and Strategic Integration

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8IPP01 Green	9IPP1 Green	None	ST-11-13 Green	ST-12-13 Green	ST-13-6 Green

API AR-13-3: Conduct human-in-the-loop simulations for taxi operations conformance, which will reduce fuel consumption during movement on the airport surface.

Contributing Theme: Aeronautics
Contributing Program(s): Airspace Systems

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8AT05 Green	9AT5 Green	10AT05 Green	AR-11-3 Green	AR-12-5 Green	AR-13-3 Green

API AMO-13-9: Achieve savings in contract costs of $10 million in FY 2013, using FY 2012 as the baseline from which to measure savings.

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	AMO-13-9 Green

Performance Goal 5.3.2.1: Ensure that testing capabilities are available in order to support the research, development, test and engineering milestones of NASA and Department of Defense (DoD) programs.

FY 2011	FY 2012	FY 2013
5.3.2.1 Green	5.3.2.1 Green	5.3.2.1 Green

During FY 2013, NASA continued to make targeted investments in its capabilities so that the Nation's aeronautics community has the tools to deliver the technology innovations and breakthroughs necessary to address the increasingly complex research and development challenges associated with safe and effective real-world flight.

In March 2013, NASA first tested and then validated Glenn Research Center's recently modified Propulsion Systems Laboratory. The new engine icing capability provides a unique high-altitude, ice-crystal-generation capability to test a fully operating turbofan engine at the temperatures, pressures, and air speeds representative of those encountered in flight. Spray bars emit a cloud of moisture so that

researchers can safely observe what happens inside a full-scale jet engine. Watch the facility in action in this NASA video.

NASA also modified a test facility at Langley Research Center by installing test section acoustic insulation improvements, a new compact jet engine simulator and fuel system, and microphone array and array traversing system at the 14x22-Foot Subsonic Wind Tunnel. This unique new acoustic measurement capability provides combined airframe and engine acoustic testing to enable research in advanced aircraft configurations, and the validation of current and new noise prediction methods. The first test of this new capability successfully demonstrated the noise reduction potential of the hybrid wing body aircraft configuration. NASA also used the capability to research the potential for noise reduction in aircraft flaps and landing gear on a semi-span model of a Gulfstream G550 aircraft.

To aid in the understanding of the current condition and reliability of the Aeronautics test assets and their ability to meet current and future (five-year horizon) test requirements, NASA established a formal process of conducting periodic assessments. In FY 2013, NASA conducted the first of these assessments on the Flight Loads Laboratory, Western Aeronautical Test Range (watch the facility in action in this video), and Flight Simulation Lab, and obtained valuable knowledge of the ground-based assets that support critical flight testing. The assessment will inform strategic investment decisions to ensure that relevant flight testing capabilities continue to be available to support the research, development, test, and engineering milestones of NASA and Department of Defense programs.

API SFS-13-3: Continue to establish and develop the 21st Century Space Launch Complex (21stCSLC) and implement the modifications identified during the FY 2011 initiated studies.

Contributing Theme: Space and Flight Support
Contributing Program(s): 21st Century Space Launch Complex

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	SFS-11-4 Yellow	SFS-12-4 Green	SFS-13-3 Green

Performance Goal 5.5.1.1: Working with the ISS National Laboratory management entity, expand utilization of ISS by non-NASA organizations.

FY 2011	FY 2012	FY 2013
5.5.1.1 Green	None	5.5.1.1 Green

NASA continued to expand non-NASA utilization of the ISS National Laboratory through the Center for the Advancement of Science in Space (CASIS). During FY 2013, CASIS established an agreement with Novartis to conduct research of the efficacy of a drug candidate on the ISS in 2014. Novartis is funding the research activities supporting this project.

The NASA Office of Inspector General (OIG) noted in its July 8, 2013, audit report, "NASA's Efforts to Maximize Research on the International Space Station," that early performance measures related to management of the ISS National Laboratory by CASIS "focused primarily on achieving organizational milestones rather than measuring how successful CASIS has been in encouraging research on the ISS." As of FY 2013, the annual performance indicators measure CASIS' success in increasing non-NASA research on the ISS.

API ISS-13-9: Facilitate the non-profit organization's (NPO) establishment of the ISS National Laboratory Marketplace to allow researchers and prospective investors to interact and to demonstrate its effectiveness by producing at least one externally funded research agreement.

Contributing Theme: International Space Station
Contributing Program(s): International Space Station

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	ISS-11-6	None	ISS-13-9 Green

API ED-13-2: Maintain no fewer than 1,000 online STEM-based teaching tools for K-12 and informal educators and higher education faculty.

Contributing Theme: Education
Contributing Program(s): STEM Education and Accountability

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ED05 Green	9ED7 Green	10ED07 Green	ED-11-3 Green	ED-12-3 Green	ED-13-2 White

API ED-13-3: Conduct no fewer than 200 interactive K-12 student activities that leverage the unique assets of NASA's missions.

Contributing Theme: Education
Contributing Program(s): STEM Education and Accountability

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
8ED04 Green	9ED8 Green	10ED08 Green	ED-11-5 Green	ED-12-5 Green	ED-13-3 Green

Performance Goal 6.2.1.3: Increase NASA's engagement in national STEM education policy discussions to improve curricula, inform national standards in STEM subjects, and ensure coordination and sharing of best practices across federal STEM agencies to avoid duplication, overlap, or fragmentation.

FY 2011	FY 2012	FY 2013
None	None	6.2.1.3 Green

Due to the increased national focus on science, technology, engineering, and mathematics (STEM) education, NASA Education has made it a priority to ensure its involvement in activities focused on the national effort to positively impact the Nation's STEM education crisis. In FY 2012, NASA Education participated on approximately 51 STEM education advisory boards, STEM-related committees, and other events related to national STEM education policy.

Note: NASA Education receives its performance data on the school calendar year cycle instead of the federal government fiscal year. Data being reporting in support of FY 2013 progress may date back to FY 2012.

API ED-13-4: Participate in no fewer than 20 STEM education advisory boards, STEM-related committees, or other events or activities related to national STEM education policy.

Contributing Theme: Education
Contributing Program(s): STEM Education and Accountability

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	None	None	ED-13-4 Green

Performance Goal 6.3.1.1: By 2015, establish an Agency-wide portfolio of participatory engagement opportunities.

FY 2011	FY 2012	FY 2013
6.3.1.1 Green	6.3.1.1 Green	6.3.1.1 Green

NASA requires all of its mission-oriented programs and projects to have a Communications plan, which is reviewed by the Communications Coordinating Council member to ensure the planned communication activities are aligned with NASA communications and outreach activities and requirements. These planned activities are submitted for review through a waiver request process. NASA is building a portfolio of existing and new communications activities, including participatory engagement

opportunities, through this process. During FY 2013, the Communications Coordinating Council continued to keep records of the activities submitted through the waiver request process.

API AMO-13-12: Evaluate portfolio of participatory engagement activities and establish best practices.

Contributing Theme: Agency Management and Operations
Contributing Program(s): Agency Management

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
None	None	None	AMO-11-20 Green	AMO-12-20 White	AMO-13-12 Green

Performance Goal 6.4.3.1: Make available Agency records through the Freedom of Information Act (FOIA), Privacy Act, and Open Government Initiative in accordance with federal laws and regulations.

FY 2011	FY 2012	FY 2013
6.4.3.1 Green	6.4.3.1 Green	6.4.3.1 Green

NASA's FOIA staff is continually improving the process to provide information and is meeting all federal laws and regulations. During FY 2013, NASA surpassed the target of decreasing the backlog of FOIA requests by 10 percent. They continued to improve overall timeliness for responding to requests and maintaining the administrative record.

Changes to the FY 2014 Performance Plan

Each fiscal year, NASA's budget request to Congress contains an Annual Performance Plan (APP) that aligns with the funds requested. Changes to a performance plan are generally reflected in the next year's budget request, if the change is known before the request is sent to Congress. If a change occurs after, then it is reflected in the Annual Performance Report. NASA updates measures in the APP when the final appropriation differs from the amount requested, or if Congressional or Executive direction places a different emphasis on programs relative to what was initially requested. Additionally, the dynamic nature of research and development can lead to shifting priorities. This may result in NASA no longer pursuing activities originally identified in the APP or placing greater emphasis on another activity.

NASA's policy has been to allow one of the following actions if programs are impacted by Congressional budget action via an appropriations or authorization law or Executive direction places a different emphasis on programs:

- Eliminate the performance measure (do not rate the performance measure);
- Change the targeted performance (rate at the new target); or
- Move the measure to the next year's APP (do not rate until the following year).

If priorities have shifted due to the dynamic nature of research and development, and the activity is no longer pursued, NASA generally retains the measure and does not reduce the target, but rather reflects this via a White rating. If emphasis is shifted onto a program for which there was no measure, NASA may choose to add a measure and rate it, to reflect the priority of that activity. Details on NASA's rating scales and criteria are in the "NASA's Approach to Performance Management" section of this appendix.

FY 2014 Performance Plan Update

NASA submitted the FY 2014 Performance Plan with its FY 2014 Congressional Justification in April 2013. Since then, NASA's review of the FY 2014 measures in light of the new Strategic Plan necessitates updating the order, numbering, and content. Additionally, NASA has updated the plan to address typographical errors or other inaccuracies and changes to NASA's budget structure. This has resulted in more changed measures than is typical.

The list shows all measures that have been updated. Due to the unusually high number, NASA has not provided detailed explanations.

Strategic Goal 1: Expand the frontiers of knowledge, capability, and opportunity in space.

1.1.1: Complete critical milestones in the development of the Space Launch System, Orion, and Exploration Ground Systems for the human exploration of deep space. (Agency Priority Goal)

ESD-14-1: Complete the Critical Design Review (CDR) of the Space Launch System (SLS) Core Stage.

ESD-14-2: Complete Orion manufacturing and assembly so the spacecraft is ready for launch vehicle integration for the Exploration Flight Test 1 (EFT-1).

1.1.2: Complete Systems Requirements Reviews by FY 2015 for the Resource Prospector Mission and In-Situ Resource Utilization Demonstration Experiment on Mars 2020 mission.

ERD-14-2: Complete International Lander contribution assessments for the robotic precursor mission.

ERD-14-3: Award contracts to industry to fabricate and test several proof of concept asteroid capture mechanisms.

ERD-14-6: Define the payload concept for the In-Situ Resource Utilization Demonstration Experiment on Mars 2020 mission.

1.1.3: ERD-14-4: Test Autonomous Mission Operations software for the International Space Station to reduce crew's dependence on ground-based mission control.

1.1.4: Mature environmental control and life support system (ECLSS) technology to enable human exploration beyond low Earth orbit.

ERD-14-5: Conduct integrated subsystem tests for improved water recovery and more reliable atmosphere revitalization systems.

1.2.1: Increase utilization of the International Space Station's internal and external research facilities. (Agency Priority Goal)

ISS-14-4: Increase facility occupancy beyond the FY 2013 baseline of 60 percent.

1.2.3: Advance engineering, technology, and science research.

ISS-14-3: Accomplish a minimum of 90 percent of the on-orbit research and technology development objectives.

1.2.4: Ensure vital assets are ready, available, and appropriately sized to conduct NASA's Mission.

SFS-14-7: Appropriately size the astronaut corps to provide timely assignments based upon mission needs.

1.2.5: ISS-14-6: Conduct successful Critical Design Reviews (CDR) for four physical science payloads and a Preliminary Design Review (PDR) for the Cold Atom Laboratory in FY 2014.

1.2.5: ISS-14-7: CASIS will release two Requests for Proposals, complete proposal evaluation, and select research projects for ISS execution in FY 2014.

1.2.5: ISS-14-8: Produce 450 peer-reviewed publications from projects in human research, space biology, and physical sciences.

1.3.1: Facilitate the development of and certify U.S. industry-based crew transportation systems while maintaining competition. (Agency Priority Goal)

CS-14-1: Complete the Commercial Crew Certification Products Contracts.

1.3.2: CS-14-4: Conduct Commercial Orbital Transportation Services (COTS) demonstration flight to ISS.

1.3.2: CS-14-5: Complete the evaluation of the Commercial Crew Transportation Capability (CCtCAP) proposals and begin contract operations while maintaining competition.

1.3.3: Provide cargo transportation to support on-orbit crew members and utilization.

ISS-14-2: Complete at least three flights by U.S.-developed cargo delivery systems, delivering research and logistics hardware to ISS.

1.4.1: Demonstrate progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.

HE-14-1: Demonstrate planned progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.

HE-14-2: Complete mission success criteria for the Van Allen Probes mission.

1.4.2: Demonstrate progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system.

HE-14-4: Demonstrate planned progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system.

1.4.3: Demonstrate progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.

HE-14-7: Demonstrate planned progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.

1.4.4: By December 2017, launch two missions in support of Strategic Objective 1.4.

HE-14-5: Complete Solar Orbiter Collaboration Heavy Ion Sensor (HIS) Instrument Critical Design Review (CDR).

HE-14-6: Complete Solar Probe Plus (SPP) Preliminary Design Review (PDR).

1.5.1: Demonstrate progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact and evolve.

PS-14-1: Demonstrate planned progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact and evolve.

1.5.2: Demonstrate progress in exploring and observing the objects in the solar system to understand how they formed and evolve.

PS-14-4: Demonstrate planned progress in exploring and observing the objects in the solar system to understand how they formed and evolve.

1.5.3: Demonstrate progress in exploring and finding locations where life could have existed or could exist today.

PS-14-5: Demonstrate planned progress in exploring and finding locations where life could have existed or could exist today.

PS-14-6: Complete mission success criteria for Mars Science Laboratory (MSL).

1.5.4: Demonstrate progress in improving the understanding of the origin and evolution of life on Earth to guide search for life elsewhere.

PS-14-8: Demonstrate planned progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.

1.5.5: Demonstrate progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.

PS-14-12: Demonstrate planned progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.

1.5.6: By December 2017, launch at least two missions in support of Strategic Objective 1.5.

PS-14-2: Complete the Origins Spectral Interpretations Resource Identification Security- Regolith Explorer (OSIRIS-REx) Critical Design Review (CDR).

PS-14-3: Complete the Interior Exploration using Seismic Investigations, Geodesy and Heath Transport (InSIGHT) mission (Discovery 12) Critical Design Review (CDR).

PS-14-7: Launch the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) mission.

1.6.1: Launch the James Webb Space Telescope. (Agency Priority Goal)

JWST-14-1: Complete JWST Spacecraft Critical Design Review (CDR).

1.6.2: Demonstrate progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter and gravity.

AS-14-1: Demonstrate planned progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter and gravity.

1.6.3: Demonstrate progress in exploring the origin and evolution of the galaxies, stars and planets that make up the universe.

AS-14-3: Demonstrate planned progress in exploring the origin and evolution of the galaxies, stars and planets that make up the universe.

AS-14-5: Conduct Stratospheric Observatory for Infrared Astronomy (SOFIA) science flights to provide a minimum of 260 research hours.

1.6.4: Demonstrate progress in discovering and studying planets around other stars and exploring whether they could harbor life.

AS-14-6: Demonstrate planned progress in discovering and studying planets around other stars, and exploring whether they could harbor life.

1.6.5: By December 2018, launch at least one mission in support of Strategic Objective 1.6.

AS-14-7: Complete the Transiting Exoplanet Survey Satellite (TESS) System Requirements Review (SRR).

1.7.1: Explore and advance promising early stage solutions to space technology challenges through investment across the U.S. innovation community.

ST-14-1: Research, study, or develop concepts for 150 technologies, as documented in technology reports or plans.

1.7.2: Advance technologies that offer significant improvement to existing solutions or enable new space science and exploration capabilities.

ST-14-2: Complete at least seven feasibility studies, ground demonstrations, or laboratory experiments proving the technical feasibility of new space technologies.

1.7.3: Mature new crosscutting space technology capabilities for demonstration.

ST-14-3: Complete four Key Decision Points for small spacecraft projects to demonstrate game changing or crosscutting technologies in space.

ST-14-4: Complete three Key Decision Points for Technology Demonstration Mission (TDM) technology development projects.

Strategic Goal 2: Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.

2.1.1: Develop solutions that will advance decision-making ability for improving air traffic management to accommodate future growth in air travel, and for increasing aviation safety under hazardous conditions.

AR-14-3: Provide an integrated, high-fidelity simulator demonstration of an aerodynamic model that supports flight crew training requirements for assuring safe aircraft control.

AR-14-4: Develop a scheduling tool that reduces departure delays by enabling efficient aircraft departure and merging into open slots in the congested overhead traffic stream.

2.1.2: Demonstrate the ability to reduce sonic booms, enabling future industry innovation in commercial supersonic aircraft.

AR-14-12: Complete Low Boom Flight Demonstrator (LBFD) conceptual design.

2.1.3: Advance airframe and engine technologies to enable the development of future generations of ultra efficient aircraft that minimize environmental impact.

AR-14-10: Execute data acquisition and control systems upgrades for the Glenn Research Center 10x10-Foot Supersonic Wind Tunnel.

AR-14-11: Execute data measurement techniques and flow quality improvements at the Langley Research Center National Transonic Facility.

AR-14-5: Use highly-detailed experimental and computer simulations to determine the potential of the truss-braced wing technology concept to enable reduced fuel use in transport aircraft.

AR-14-9: Conduct a successful Project Formulation Review and establish an advanced composites consortium to accelerate the development and certification process for advanced composite structures.

2.1.4: Facilitate significant environmental and efficiency improvements through research on alternative jet fuel use and on hybrid gas-electric propulsion system concepts.

AR-14-13: Model and design a fully superconducting electric generator for novel aircraft propulsion applications.

2.1.5: Significantly increase the ability to anticipate and resolve potential safety issues and predict the health and robustness of aviation systems.

AR-14-1: Conduct a ground-based demonstration of a wireless sensor that provides lightning protection and can detect and diagnose damage in composite structures.

2.1.6: Support transformation of civil aircraft operations and air traffic management through the development, application, and validation of advanced autonomy and automation technologies, including addressing critical barriers to future routine access of Unmanned Aircraft Systems (UAS) in the National Airspace System, through the development and maturation of technologies and validation of data.

2.2.1: Demonstrate progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.

ES-14-1: Demonstrate planned progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.

2.2.2: Demonstrate progress in improving the capability to predict weather and extreme weather events.

ES-14-3: Demonstrate planned progress in improving the capability to predict weather and extreme weather events.

2.2.3: Demonstrate progress in detecting and predicting changes in Earth's ecological and chemical cycles, including land cover, biodiversity, and the global carbon cycle.

ES-14-6: Demonstrate planned progress in detecting and predicting changes in Earth's ecological and chemical cycles, including land cover, biodiversity, and the global carbon cycle.

2.2.4: Demonstrate progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.

ES-14-7: Demonstrate planned progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.

2.2.5: Demonstrate progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.

ES-14-9: Demonstrate planned progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.

2.2.6: Demonstrate progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.

ES-14-11: Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.

2.2.7: Further the use of Earth system science research to inform decisions and provide benefits to society.

ES-14-12: Advance at least 25 percent of decision-support projects one Applications Readiness Level.

ES-14-14: Maintain a high level of customer satisfaction, as measured by exceeding the most recently available Federal government average rating of the Customer Satisfaction Index.

2.2.8: By December 2017, launch at least five missions in support of Strategic Objective 2.2.

ES-14-2: Complete the Orbiting Carbon Observatory (OCO)-2 observatory testing.

ES-14-5: Complete Cyclone Global Navigation Satellite System (CYGNSS/EV-2) Preliminary Design Review (PDR).

ES-14-10: Deliver the Ice, Cloud, and Land Elevation Satellite (ICESat)-2 flight lasers.

ES-14-18: Complete the Gravity Recovery and Climate Experiment (GRACE) Follow-On mission Preliminary Design Review (PDR).

2.3.1: Implement the five-year Strategic Plan to improve the ability to transfer NASA-developed technologies.

ST-14-8: The Agency will develop and implement two innovative methods for technology licensing.

2.3.2: Implement a process that enables the Agency to define and lead the Agency Grand Challenge.

ST-14-9: Establish at least two new "open innovation" mechanisms that leverage external support for the Asteroid Grand Challenge.

2.4.1: Assure that students participating in NASA higher education projects are representative of the diversity of the Nation.

ED-14-1: Provide significant, direct student awards in higher education to (1) students across all institutional levels and types (as defined by the U.S. Department of Education); (2) racially or ethnically underrepresented students, (3) women, and (4) persons with disabilities at percentages that meet or exceed the national percentages for these populations, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the four categories.

2.4.2: Continue to support STEM educators through the delivery of NASA education content and engagement in educator professional development opportunities.

ED-14-6: 250,000 educators participate in NASA-supported professional development, research, and internships that use NASA-unique STEM content.

2.4.3: Assure that the institutions NASA engages with represent the diversity of institution types and levels in the Nation as defined by the U.S. Department of Education.

2.4.4: Continue to provide opportunities for learners to engage in STEM education through NASA-unique content provided to informal education institutions designed to inspire and educate the public.

ED-14-5: Maintain the NASA Museum Alliance and/or other STEM education strategic partnerships in no fewer than 30 states, U.S. territories and/or the District of Columbia.

2.4.5: Continue to provide opportunities for learners to engage in STEM education engagement activities that capitalize on NASA-unique assets and content.

ED-14-8: One million elementary and secondary students participate in NASA STEM engagement activities.

Strategic Goal 3: Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure.

3.1.1: AMO-14-1: Sustain FY 2013 Innovation Score, as measured by the Innovation-related questions of the Employee Viewpoint Survey (EVS), by taking actions such as refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.

3.1.2: Advance a workplace environment that affords equal employment opportunities (EEO) to all employees and takes proactive diversity and inclusion efforts.

> AMO-14-2: Assess, evaluate, and report the success of the NASA Model EEO Agency Plans FY 2008 to FY 2013.
>
> AMO-14-3: Evaluate overall progress and effectiveness of the Agency Diversity and Inclusion Strategic Implementation Plan to date, in preparation for its completion in fiscal year in FY 2015.

3.1.3: AMO-14-11: Provide a civil rights compliance assessment at a minimum of two STEM or STEM-related programs that receive NASA funding.

3.1.4: Between 2012 and 2016, support the demolition and elimination of obsolete and unneeded facilities.

3.1.5: Manage coordination of NASA's international and interagency activities in conjunction with the NASA mission directorates.

> AMO-14-26: Revise the NASA export control training module to update and strengthen the content to reflect changes in regulations and to respond to audit findings.
>
> AMO-14-9: Negotiate and conclude international and interagency agreements with foreign and domestic partners in support of NASA missions.

3.1.6: AMO-14-30: Achieve savings through increased use of both Federal-level and Agency-level strategic sourcing vehicles.

3.1.6: AMO-14-8: Achieve savings through increased contract efficiencies and reduced transaction costs in NASA procurements.

3.1.7: Ensure that NASA continues progress towards implementing statutory or Executive Order targets and goals reflected in its annual Sustainability Plan.

> AMO-14-20: Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) by 27 percent from 2003 baseline under 42 U.S.C. 8253.
>
> AMO-14-21: Attain 14 percent sustainable building inventory by 2014.
>
> AMO-14-22: Ensure that at least 7.5 percent of electricity is generated from renewable energy sources.

3.1.8: Enhance reach and effectiveness of programs and projects that engage the public.

AMO-14-13: Use current and emerging communications technologies to reach increasingly broad audiences.

AMO-14-28: Assess the use of NASA content by completing the portfolio of communications activities being built through the Communications Coordinating Council governance process.

3.1.9: Manage coordination of advisory committees' (NASA Advisory Committee and Aerospace Safety Advisory Panel) recommendations to the NASA Administrator.

AMO-14-27: Provide NASA responses to advisory committees' recommendations made formally to the NASA Administrator.

3.2.1: SFS-14-1: Sustain 90 percent availability of test facilities to support NASA and other customer's planned test requirements.

3.2.2: SFS-14-2: Sustain a 100 percent success rate with the successful launch of NASA managed expendable launches as identified on the Launch Services Flight Planning Board manifest.

3.2.2: SFS-14-3: Complete acquisitions on time for NASA-managed expendable launches.

3.2.3: SFS-14-4: Complete in-orbit check-out of Tracking and Data Relay Satellite (TDRS)-L spacecraft.

3.2.4: By FY 2016, replace or upgrade obsolete and unsustainable systems of the Tracking and Data Relay Satellite System (TDRSS) Ground Segment at the White Sands Complex (WSC).

SFS-14-5: Make progress towards the Space Network Ground Segment Sustainment (SGSS) Systems Integration Review (SIR).

3.2.5: By FY 2018, replace aging Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).

SFS-14-6: Complete the radio frequency equipment installation at Canberra Deep Space Communications Complex (CDSCC) to support operations.

3.2.6: ESD-14-4: Complete environmental mitigation projects to support horizontal take-off, horizontal landing commercial partner at the Shuttle Landing Facility (SLF); complete development of the Deployable Launch System and Universal Propellant Servicing System to enable a small-class vehicle launch capability at Kennedy Space Center (KSC); and begin range telemetry systems upgrades.

3.2.7: Ensure the strategic availability and maintenance of facilities that are necessary to meet the long-term needs and requirements of the Agency.

SC-14-1: Achieve a minimum of 80 percent overall availability of Strategic Capabilities Assets Program (SCAP) portfolio of assets, which are necessary to meet the long-term needs and requirements of the Agency.

3.3.1: Enhance NASA's information security posture through implementation of automated security and privacy tools and technologies.

AMO-14-17: Identify new tools and technologies needed to support automated security and privacy systems.

AMO-14-19: Achieve 95 percent implementation of continuous monitoring cybersecurity capabilities.

AMO-14-23: Achieve 50 percent implementation of strong authentication cybersecurity capabilities.

AMO-14-24: Achieve 99 percent implementation of Trusted Internet Connection consolidation cybersecurity capabilities.

AMO-14-25: Achieve 100 percent implementation of Trusted Internet Connection 2.0 cybersecurity capabilities.

3.3.2: Identify viable alternatives to support Federal and Agency mobility goals, supporting Work from Anywhere (WFA).

AMO-14-18: Implement a Mobile Device Management (MDM) capability to support access to NASA email and calendaring services from government and personally-owned mobile devices.

3.3.3: Consolidate and centralize the management of information technology (IT) enterprise services for end user services, communications, and enterprise applications.

AMO-14-29: Transition 150 Web applications to the cloud.

3.3.4: By 2015, reduce the number of data centers to 22.

AMO-14-7: Maintain the FY 2014 schedule of five data center consolidations contained in NASA Federal Data Center Consolidation Plan.

3.4.1: Assure the safety and health of NASA's activities and reduce damage to assets through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, quality assurance, and health and medical policies and procedures.

AMO-14-5: Maintain a Total Case Rate and Lost Time Case Rate that meets or exceeds the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.

AMO-14-6: Reduce damage to NASA assets (excluding launched flight hardware) by two percent during FY 2014, based on a five-year running average (that also excludes launched flight hardware).

3.4.2: Implement the policies, procedures and oversight to continuously improve the probability of technical and programmatic mission success.

AMO-14-15: Ensure 100 percent of Category 1 and 2 projects use Agency Safety and Mission Success policy, procedures and independent assessments focused on both technical and programmatic mission success.

AMO-14-16: Ensure that 100 percent of the engineering and programmatic workforce has access to the standards and knowledge base needed to maintain and build their skills.

Removed Performance Measures

ST-14-6: Complete Key Decision Point B for the Cryogenic Propellant Storage and Transfer demonstration.

2.1.1.2: By 2015, launch at least two missions in support of objective 2.1.1.

2.1.2.2: By 2015, launch at least two missions in support of objective 2.1.2.

2.1.3.2: By 2015, launch at least two missions in support of objective 2.1.3.

2.1.4.2: By 2015, launch at least two missions in support of objective 2.1.4.

2.1.5.3: By 2015, launch at least three missions in support of objective 2.1.5.

2.1.6.2: By 2015, launch at least one mission in support of objective 2.1.6.

2.2.1.2: By 2015, launch two missions in support of objective 2.2.1.

2.2.2.2: By 2015, launch two missions in support of objective 2.2.2.

2.2.3.2: By 2017, launch at least two missions in support of objective 2.2.3.

2.3.1.2: By 2017, launch at least two missions in support of objective 2.3.1.

2.3.2.2: By 2015, launch at least three missions in support of objective 2.3.2.

2.3.3.2: By 2015, launch at least two missions in support of objective 2.3.3.

PS-14-9: Demonstrate planned progress in identifying and characterizing small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

2.3.5.2: Return data for selection of destinations in order to lower risk for human space exploration beyond low Earth orbit.

PS-14-11: Demonstrate planned progress in characterizing potentially hazardous objects that are possible destinations for future human space exploration.

2.4.2.3: Develop and operate an airborne infrared astrophysics observatory.

3.3.2.2: Develop technologies and mission concepts for demonstrating in-space cryogenic propellant storage and transfer making exploration and science missions more affordable and capable.

3.4.1.1: Accelerate the development and adoption of NASA-funded technology through the establishment of cost-sharing partnerships.

ST-14-7: To reduce the time it takes to process a NASA Space Act Agreement (SAA), initiate an NASA study and implement steps that result in a 10 percent reduction in time at least 5 NASA Centers in FY2014.

AR-14-6: Demonstrate the noise reduction and performance benefits of active twist concepts for rotor control for rotary wing aircraft through wind tunnel testing

5.3.2.1: Ensure that testing capabilities are available in order to support the research, development, test and engineering milestones of NASA and Department of Defense (DoD) programs.

6.2.1.3: Increase NASA's engagement in national STEM education policy discussions to improve curricula, inform national standards in STEM subjects, and ensure coordination and sharing of best practices across federal STEM agencies to avoid duplication, overlap, or fragmentation.

6.3.1.1: By 2015, establish an Agency-wide portfolio of participatory engagement opportunities.

AMO-14-12: Develop standardized Agency metrics for assessing success of participatory engagement activities.

6.4.3.1: Make available Agency records through the Freedom of Information Act (FOIA), Privacy Act, and Open Government Initiative in accordance with federal laws and regulations.