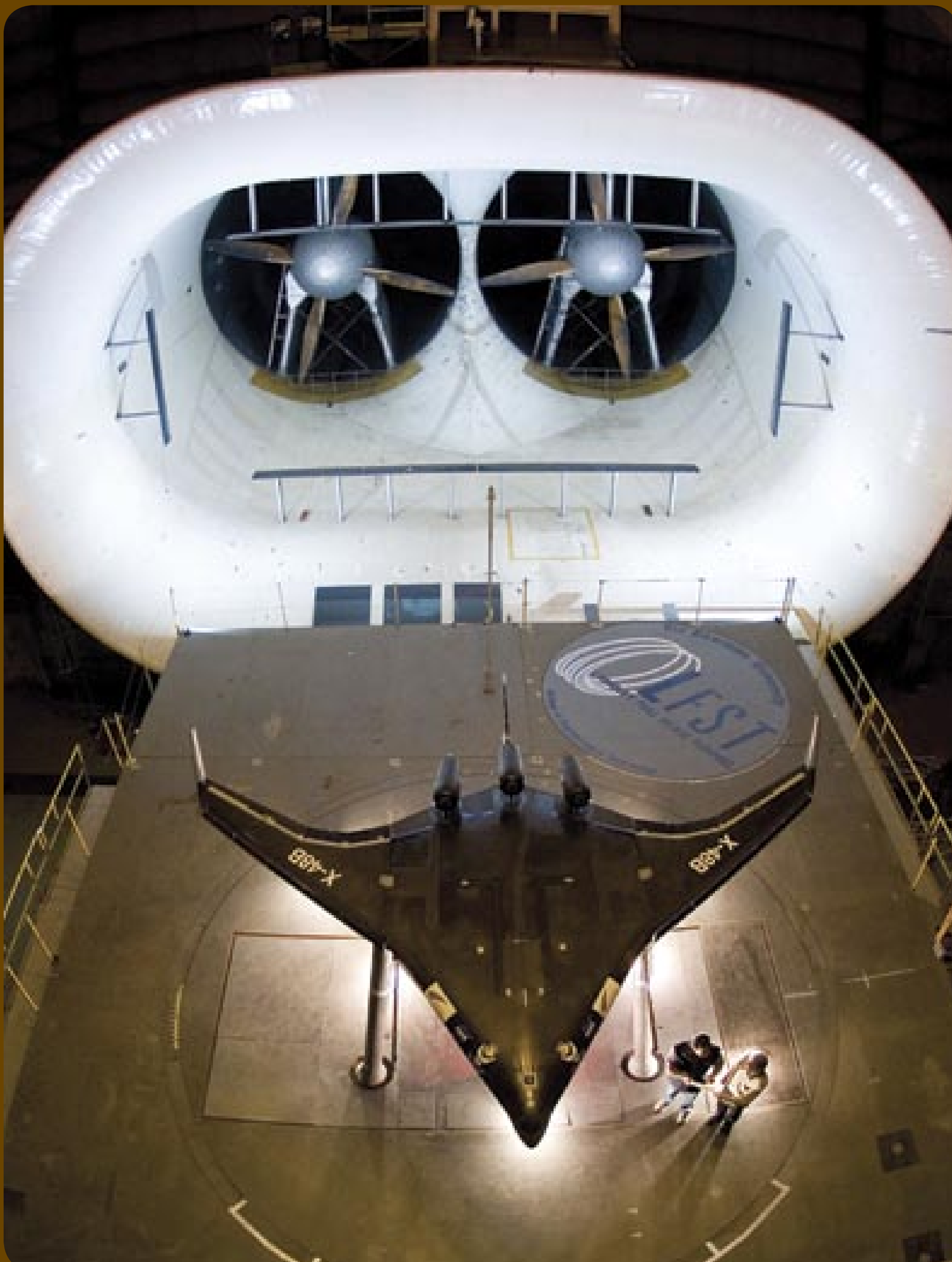
National Aeronautics and Space Administration

Fiscal Year 2006 Performance and Accountability Report

Table of Contents



Part 2: Detailed Performance Data

Previous page: Researchers at NASA's Langley Research Center prepare a 21-foot-wingspan, 8.5-percent-scale prototype of a blended wing body aircraft for testing at Langley's historic full-scale wind tunnel. Boeing Phantom Works has partnered with NASA and the Air Force Research Laboratory to study the structural, aerodynamic, and operational advantages of the advanced aircraft concept, which is a cross between a conventional plane and a flying wing design. (Boeing Phantom Works/B. Ferguson)

Above: Engineers at NASA's Dryden Flight Research Center conduct vibration testing on the F-15B testbed aircraft to prepare it for test flights of the Quiet Spike sonic boom mitigator. Researchers at NASA and Gulfstream Aerospace developed the telescopic Quiet Spike (shown here extended from the nose of the aircraft) as a means of controlling and reducing the sonic boom caused by an aircraft "breaking" the sound barrier. (NASA/T. Landis)

Detailed Performance Data

NASA's Performance Rating System

In February, NASA issued the 2006 NASA Strategic Plan, reflecting the Agency's focus on achieving the Vision for Space Exploration through six Strategic Goals and, under Strategic Goal 3, six Sub-goals. At the same time, NASA updated the Agency's FY 2006 Performance Plan to include multi-year and annual performance metrics that NASA will pursue in support of the new Strategic Goals.

Part 2: Detailed Performance Data describes each Strategic Goal and Sub-goal and provides a detailed performance report and color rating, including trend data, for each of NASA's 37 multi-year Outcomes and 165 Annual Performance Goals (APGs). The FY 2006 NASA Performance Improvement Plan, included at the end of this part, provides further information on performance shortfalls and the Agency's plans to achieve the unmet multi-year Outcomes and APGs in the future.

NASA managers assign annual performance ratings to each multi-year Outcome and APG based on a number of factors, including internal assessments of performance against plans in such areas as budgets, schedules, and key milestones. Managers also consider input from external reviewers, including NASA advisors and experts from the science community, as well as recommendations from the Office of Management and Budget.

NASA rates performance as follows:

Multi-year Outcome Rating Scale

Green	NASA achieved most APGs under this Outcome and is on-track to achieve or exceed this Outcome.
Yellow	NASA made significant progress toward this Outcome, however, the Agency may not achieve this Outcome as stated.
Red	NASA failed to achieve most of the APGs under this Outcome and does not expect to achieve this Outcome as stated.
White	This Outcome was canceled by management directive or is no longer applicable based on management changes to the APGs.

APG Rating Scale

Green	NASA achieved this APG.
Yellow	NASA failed to achieve this APG, but made significant progress and anticipates achieving it during the next fiscal year.
Red	NASA failed to achieve this APG, and does not anticipate completing it within the next fiscal year.
White	This APG was canceled by management directive, and NASA is no longer pursuing activities relevant to this APG.

In FY 2006, NASA achieved 84 percent of the Agency's 37 multi-year Outcomes, as shown in Figure 1. NASA also achieved 70 percent of the Agency's 165 APGs. NASA rated 12 percent of the Agency's APGs Yellow and 18 percent either Red or White. In previous years, NASA rated performance that exceeded expectations and measures Blue; however, NASA discontinued this rating as of FY 2006. (See Figure 2 for a summary of NASA's APG ratings for FY 2006.)

Figure 1: Summary of NASA's FY 2006 Multi-year Outcome Ratings

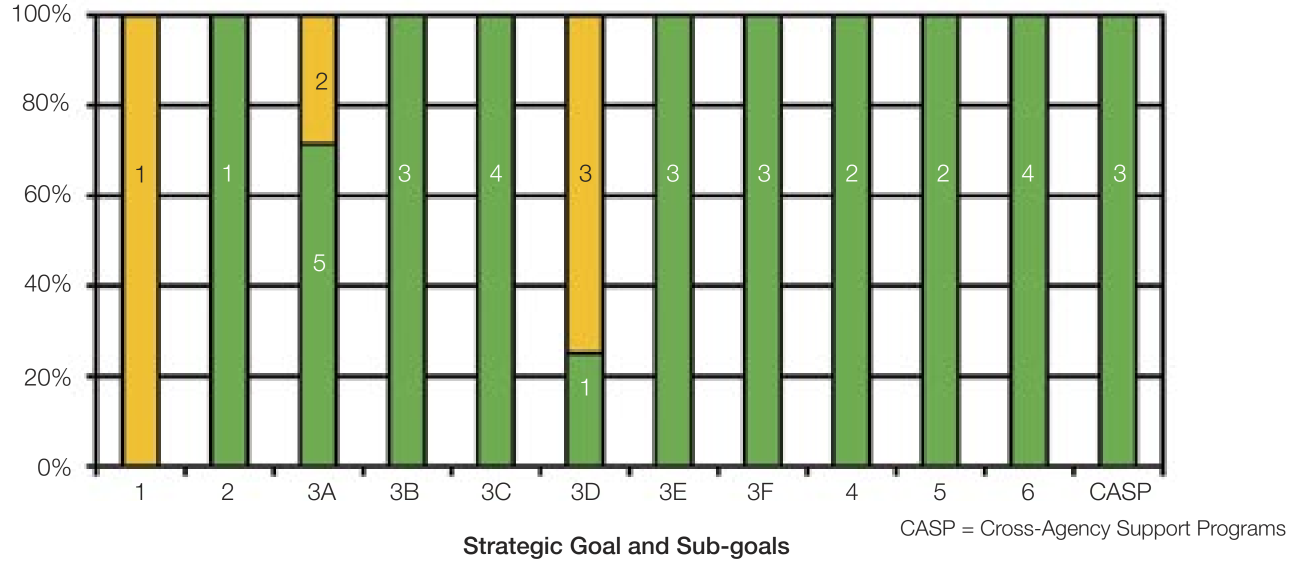


Figure 2: Summary of NASA's FY 2006 APG Ratings

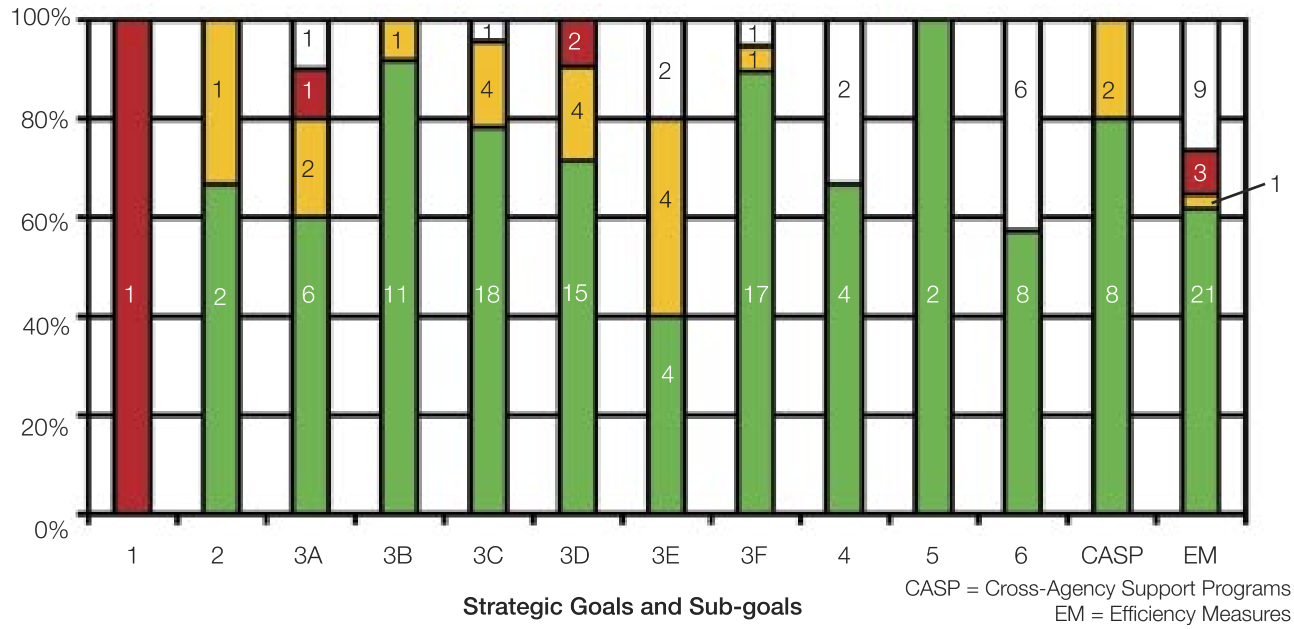
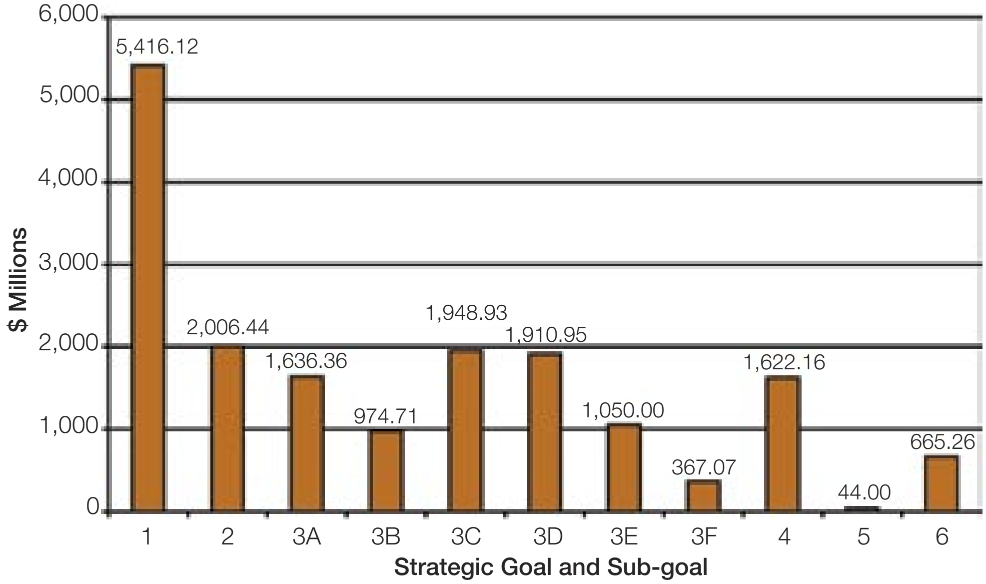


Figure 3 shows an estimate of NASA's FY 2006 expenditures toward achieving each Strategic Goal and Sub-goal. NASA's financial structure is not based on the Strategic Goals; it is based on lines of business that reflect the costs associated with the Agency's Mission Directorate and Mission Support programs. To derive the estimate of expenditures, NASA analysts reviewed and assigned each Agency program to a Strategic Goal (and Sub-goal, when appropriate), then estimated the expenditure based on each program's percentage of the business line reflected in that Strategic Goal (and Sub-goal, when appropriate). This method does not allow NASA to estimate expenditures by multi-year Outcomes or APGs. However, NASA is making progress in aligning the Agency's budget and financial structure with performance, and the Agency plans to report expenditures by multi-year Outcomes as soon as possible.

The numbers provided in the figure below and throughout the Measuring NASA's Performance chapter in Part 1: Management Discussion & Analysis are derived from the FY 2006 Statement of Net Cost included in Part 3: Financials.

Figure 3: FY 2006 Cost of Performance for NASA's Strategic Goals and Sub-goals



Strategic Goal 1 *Fly the Shuttle as safely as possible until its retirement, not later than 2010.*

By Presidential direction, NASA will retire the Space Shuttle in 2010 to make way for a new generation of space transportation vehicles with the capability to travel beyond low Earth orbit to the Moon and beyond. Currently, the Shuttle is the largest human-rated space vehicle in the world, capable of delivering both crew and massive equipment to low Earth orbit. This capability makes the Shuttle critical to completing the International Space Station (ISS) and fulfilling the Vision for Space Exploration.

The drag chute glows in the lights illuminating *Atlantis* as it touches down at Kennedy Space Center before dawn on September 21, 2006. The mission, STS-115, marked NASA's return to regular Shuttle flights and ISS construction. (NASA)

The Agency has three Shuttles in operation: *Discovery*, *Atlantis*, and *Endeavour*. NASA plans 15 to 17 Shuttle flights to support ISS assembly, plus a possible Hubble Servicing Mission before retiring the Shuttle.

In FY 2006, NASA flew two successful Shuttle missions: STS-121 and STS-115, the first ISS assembly mission since STS-113 in November 2002. During both missions, the Agency tested new techniques for monitoring the launch, examining the Shuttle for potential damage during launch, and conducting on-orbit repair to assure Shuttle integrity and crew safety.

Risks to Achieving Strategic Goal 1

The current ISS assembly schedule leaves little room for delays in launching the Shuttle. However, the safety of the Shuttle's crew is paramount, and NASA will not compromise safety for schedule. The primary external risk facing the Space Shuttle Program is inclement weather. NASA officials delayed launching STS-115 several times due to lightning, high winds, and the impact of Hurricane Ernesto. Hurricanes also have the potential to cause significant damage to the NASA facilities that support Shuttle launches.

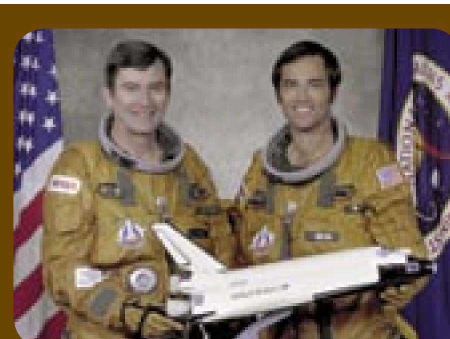
The Space Shuttle Program also faces internal risks associated with transitioning the Shuttle's workforce and facilities to support the Agency's new Constellation Systems Program, which will build NASA's next-generation space vehicles. In addition, NASA may face cost and schedule problems if any in-flight anomalies or other unacceptable

NASA Celebrates 25th Anniversary of First Shuttle Flight

On the morning of April 12, 1981, two astronauts, Commander John Young and pilot Robert Crippen, sat strapped into their seats on the flight deck of a radically new spacecraft known as the Space Shuttle, ready to make the boldest test flight in history. Designated STS-1, this first launch of Shuttle *Columbia* marked the inaugural flight of NASA's newest space transportation system and the first time a space vehicle was crewed during its maiden voyage.

In April 2006, as part of the 25th anniversary of this historic flight, NASA Administrator Michael Griffin awarded Robert Crippen the Congressional Space Medal of Honor, the Nation's highest award for spaceflight achievement. John Young received the award in 1981.

"It is unlike any other thing that we've ever built," said Crippen. "Its capabilities have carried several hundred people into space, it's carried thousands of pounds of payload into space. It gave us Hubble, it gave us Galileo, it gave us Magellan. And it's allowed us to essentially build a space station, although we've got some work still to do on that. So it is something that has been truly amazing and I'm honored to have been a part of it." The past 25 years of Shuttle flights are a testimony to NASA's dedicated workforce—the people who came together to make the Shuttle missions possible.



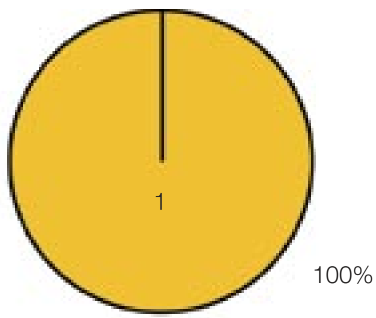
Above: John Young (left) and Robert Crippen pose with a model of *Columbia* for the first official Shuttle crew portrait. (NASA) Left: STS-1 launches from Kennedy Space Center on April 12, 1981. (NASA) program and flight risks occur beyond the scope of Space Shuttle Program reserves. If the Space Shuttle Program is delayed dramatically, NASA may not complete all ISS elements as currently agreed on with the Agency's International Partners by Shuttle retirement in 2010.

Resources, Facilities, and Major Assets

The Space Shuttle Program currently occupies 640 facilities at multiple NASA Centers and uses over 900,000 pieces of equipment. The primary operational hardware includes the three operational Shuttles and the Shuttle preparatory and launch facilities at the Kennedy Space Center, including the Vehicle Assembly Building, where the Shuttle is connected to its external tank and solid rocket boosters, the large crawler transporter that carries the Shuttle to the launch pad, and the launch tower at pad 39A. The Michoud Assembly Facility in New Orleans manufactures the external tanks and ships them to Kennedy.

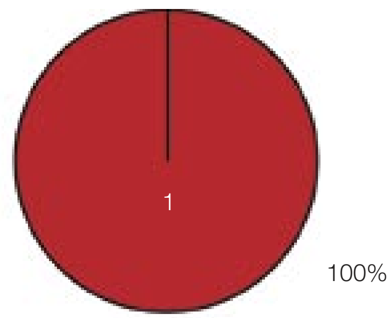
The cost of performance for Strategic Goal 1 during FY 2006 was $5,416.12 million.

Outcome Rating



Under Strategic Goal 1, NASA may not achieve the single Outcome as stated.

APG Rating



Under Strategic Goal 1, NASA failed to achieve the single APG.

Outcome 1.1: Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.

FY 2006	FY 2005	FY 2004	FY 2003
Yellow	Green	Green	None

In FY 2006, the Space Shuttle Program successfully flew two missions. STS-121 (*Discovery*), launched on July 4, 2006, was the Agency's second return to flight mission. It gave NASA engineers another opportunity to address the issue of foam loss from the Shuttle's external tank during liftoff—a problem that led to the *Columbia* accident and occurred again on the first post-*Columbia* accident mission, STS-114, launched in July 2005.

NASA continued to implement improvements introduced during the STS-114 mission: a new suite of cameras and sensors to monitor the Shuttle during launch; additional orbital maneuvers near the ISS to allow crew to check for damage; and ground procedures to provide mission managers with the high-fidelity information needed to assess Shuttle integrity. During the STS-121 mission, *Discovery* delivered cargo and supplies to the ISS and several science experiments, and crewmembers conducted spacewalks to repair the ISS Mobile Transporter, hardware critical to completing ISS construction. The second FY 2006 Shuttle mission, STS-115 (*Atlantis*), launched

Staff at Kennedy Space Center's Mission Control Center cheer and wave American flags as STS-121 launches on July 4, 2006. This was NASA's second return to flight mission and the first time the Agency had launched a Shuttle mission on Independence Day. (NASA) on September 9. *Atlantis* crewmembers successfully conducted three complex spacewalks to install the P3/P4 truss segment on the ISS and to deploy four large solar arrays.

Despite the achievements during these two missions, NASA confirmed two Type–B mishaps (damage to property of at least $250,000 or permanent disability or hospitalization of three or more persons): damage to *Discovery*'s robotic manipulator arm caused while crews were servicing the Shuttle in the Orbiter Processing Facility hangar; and damage to *Atlantis*'s coolant loop accumulator due to over-pressurization. NASA also reported a personnel injury at Kennedy Space Center's Launch Complex 39A. NASA convened a Mishap Investigation Board to decide how to classify the incident, determine the root causes, recommend corrective actions, and report their findings to NASA and other stakeholders.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SSP1 Red	Achieve zero Type–A (damage to property at least $1M or death) or Type–B (damage to property at least $250K or permanent disability or hospitalization of 3 or more persons) mishaps in 2006.	5SSP1 Green	4SSP2 Yellow	3H06 Red

Performance Shortfalls

Outcome 1.1 and 6SSP1: The Space Shuttle Program reported and investigated three major incidents in FY 2006. Two of these are confirmed Type–B mishaps. NASA is reviewing details of the third incident.

Strategic Goal 2 *Complete the International Space Station in a manner consistent with NASA's International Partner commitments and the needs of human exploration.*

The International Space Station (ISS) plays a vital role in NASA's human space exploration efforts by providing an on-orbit facility where researchers can study the effects of space travel on human health and performance over extended periods of time. NASA also uses the ISS to test technologies, capabilities, and processes for future human and robotic missions to the Moon, Mars, and beyond.

NASA launched Space Shuttle *Discovery*, STS-121, on July 4, 2006, the second return to flight mission since the *Columbia* accident in 2003 and a precursor to launching additional ISS hardware on future Shuttle flights. The mission tested new safety measures and changes to the external tank and delivered cargo and supplies to the ISS, including a piece of replacement hardware for the ISS Mobile Transporter and several science experiments. On September 9, NASA resumed ISS assembly with the launch of Shuttle *Atlantis*, STS-115. *Atlantis* ferried a major piece of infrastructure to the ISS, the P3/P4 integrated truss segment, which will provide additional power to support future modules and has a mechanism to rotate the truss sections to keep the solar arrays pointed at the Sun as the ISS orbits.

The new P3/P4 truss and solar panels are visible (running from the upper left corner to the center) in this photo taken by Shuttle *Atlantis* as it undocked from the ISS on September 17, 2006. (NASA)

Risks to Achieving Strategic Goal 2

NASA's ISS assembly schedule has limited reserves for internal and external factors that could potentially delay completion of the ISS beyond 2010. However, NASA remains committed to completing the ISS on schedule to fulfill the Vision for Space Exploration and to meet the Agency's commitments to the International Partners.

NASA enjoys the benefits of partnerships with the other nations contributing to the ISS. These partnerships enhance the Agency's ability to achieve NASA's Strategic Goals while also benefiting partner nations. However, international space agency partnerships contain multiple risks inherent with each partner country. NASA's ability to maintain international partnerships, even as world conditions and international relationships change, is important to the success of the International Space Station.

Internally, NASA must manage one of its biggest challenges: assuring a skilled and focused workforce for continued ISS and Shuttle operations while developing the post-Shuttle workforce. During FY 2006, NASA conducted internal workforce studies, and requested a workforce study by the National Research Council, to help Agency leaders develop strategies both for transitioning staff from the Space Shuttle Program to operations supporting Constellations Systems vehicle development and for assuring a highly trained, skilled workforce for current and future needs.

Resources, Facilities, and Major Assets

The single largest facility and asset supporting Strategic Goal 2 is the ISS. It represents dollar, human resource, and physical asset investments by the United States, Russia, Canada, and the European Space Agency. NASA also is processing two new modules, provided by the European Space Agency and the Japan Aerospace Exploration Agency, for launch by Shuttle in late 2007 and 2008, respectively.

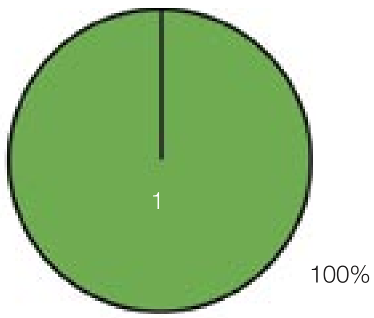
Other major resources also support Strategic Goal 2:

- The Space Shuttle fleet, the only vehicles able to carry large components to the ISS;

- The Space Station Processing Facility located at Kennedy Space Center, where NASA prepares equipment for launch;
- The Mock-up Facility at Johnson Space Center, where ISS expedition crews prepare for their missions using duplicates of on-orbit equipment and facilities; and
- The Neutral Buoyancy Laboratory at Johnson Space Center, a 6.2 million-gallon pool where expedition crews and Shuttle astronauts train for extravehicular activities like ISS construction in a simulated weightless environment.

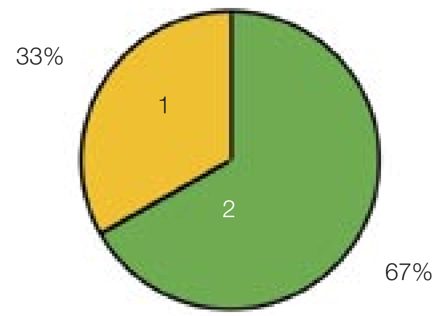
The cost of performance for Strategic Goal 2 during FY 2006 was $2,006.44 million.

Outcome Rating



Under Strategic Goal 2, NASA is on track to achieve the single Outcome.

APG Ratings



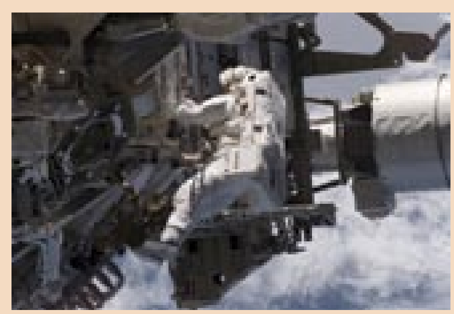
Under Strategic Goal 2, NASA achieved 2 of 3 APGs.

Outcome 2.1: By 2010, complete assembly of the U.S. On-orbit segment; launch International Partner elements and sparing items required to be launched by the Shuttle; and provide on-orbit resources for research to support U.S. human space exploration.

FY 2006	FY 2005	FY 2004	FY 2003
Green	Green	None	None

With the installation of the P3/P4 truss by the STS-115 crew in September 2006, NASA took a major step toward completing the ISS. With its solar panels fully extended, the P3/P4 truss will supply the completed ISS with a quarter of its power. The current wiring configuration restricts power generated by the truss's solar panels to the operation of the P3/P4 segment. During STS-116, scheduled for December 2006, crewmembers will continue preparing the ISS to support future modules by rewiring the power-generating truss to provide power to the rest of ISS.

NASA also made progress in FY 2006 toward achieving Outcome 2.1 through international collaboration and cooperation. In March 2006, NASA and the Agency's International Partners approved the final ISS configuration at the Heads of Agency meeting held at Kennedy Space Center. This approval allows NASA to finalize the Shuttle launch schedule for ISS assembly. NASA also contracted with the Russian Space Agency for additional cargo and launch services to the ISS via Soyuz/Progress spacecraft at a fixed rate through 2011.



Astronaut Heidemarie Stefanyshyn-Piper, STS-115 mission specialist, works near the ISS's Solar Alpha Rotary Joint during a spacewalk on September 12, 2006. This was the first of three spacewalks to add the new P3/P4 truss. (NASA)

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ISS1 Green	Reach agreement among the International Partners on the final ISS configuration.	5ISS5 Yellow	4ISS5 Green	None
6ISS3 Yellow	Provide 80 percent of FY 2006 planned on-orbit resources and accommodations to support research, including power, data, crew time, logistics and accommodations.	5ISS4 Yellow	4ISS4 Green	None
6ISS4 Green	For FY 2006 ensure 90 percent functional availability for all ISS subsystems that support on-orbit research operations.	None	None	None

Performance Shortfalls

NASA was unable to meet the original goal of regularly scheduled Shuttle flights throughout FY 2006 due to foam issues on the external tank. While these issues were resolved, NASA did not launch the Shuttle until July 2006—10 months after the start of FY 2006. Shuttle flight delays reduced actual upmass and volume capabilities.

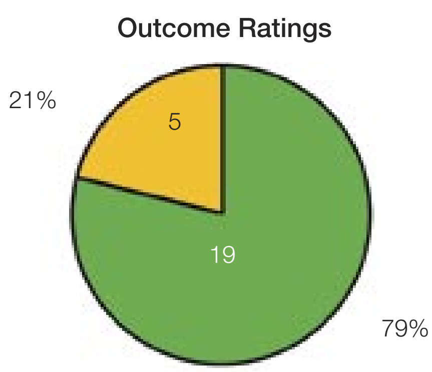
Strategic Goal 3 *Develop a balanced overall program of science, exploration, and aeronautics consistent with the redirection of the human spaceflight program to focus on exploration.*

The Vision for Space Exploration directs NASA to send human explorers to the Moon, Mars, and beyond. Strategic Goal 3 will be enabled by extensive research into human health and performance in space, development of better, smaller, and lighter life support systems, and knowledge of the environments of the Moon, Mars and beyond. The Vision also includes robotic exploration of planetary bodies in the solar system, advanced telescope searches for Earth-like planets around other stars, and the study of the origins, structure, evolution, and destiny of the universe. Additional Presidential and Congressional initiatives guide NASA's study of Earth from space and build on NASA's rich heritage of aeronautics and space science research.

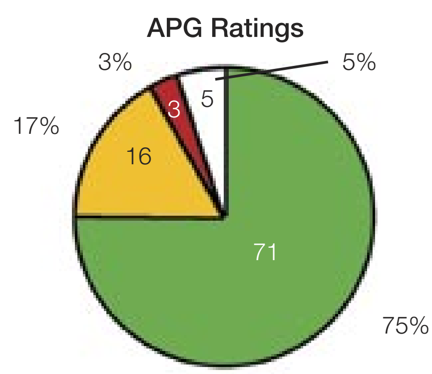
Science enables, and is enabled by, exploration. NASA's access to space makes possible research into scientific questions that are unanswerable on Earth. The International Space Station provides a laboratory to study astronaut health and test life-support technologies in zero gravity over long durations. Space-based telescopes observe the farthest reaches and earliest times in the universe. Robotic spacecraft travel to, land on, rove over, and return samples from bodies throughout the solar system. And, Earth-orbiting satellites keep watch over Earth, making regular observations of global change and enabling better predictions of climate, weather, and natural hazards.

NASA also is the lead government agency for civil aeronautics research, and aeronautics remains a core part of the Agency's Mission. NASA's aeronautics research initiatives will expand the capacity and efficiency of the Nation's air transportation system and contribute to the safety, environmental compatibility, and performance of existing and future air and space vehicles.

NASA's activities under Strategic Goal 3 are broad and varied. These activities are balanced and managed through the six supporting Sub-goals, which focus on individual facets of Strategic Goal 3. The work, achievements, and challenges for each Sub-goal are unique. Therefore, NASA reports performance achievements and challenges for each Sub-goal rather than for the over-arching Strategic Goal 3.



Under Strategic Goal 3, NASA is on track to achieve 19 of 24 Outcomes.



Under Strategic Goal 3, NASA achieved 71 of 95 APGs.

Sub-goal 3A *Study Earth from space to advance scientific understanding and meet societal needs.*

Studying Earth science is in the national interest. NASA's Earth science programs enhance scientists' understanding of the Earth system and its response to natural and human-induced changes—understanding that will lead to improved predictions of climate, weather, and natural hazards. Sub-goal 3A also supports NASA's partnership with other federal agencies pursuing Earth observation initiatives, including the Climate Change Research Initiative, the Global Earth Observation System of Systems, and the U.S. Ocean Action Plan. For example, NASA partners with the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), the Environmental Protection Agency, the Department of Defense, and other government agencies to collect and disseminate Earth science-related information to the American public.

NASA's Earth science missions use satellites, aircraft, and research stations to gather data. The collected data are used in computer models to analyze Earth's water cycle, atmospheric composition, weather patterns, ice flows, and changes in Earth's crust and oceans. NASA and Earth science partners are developing satellites to deliver the first measurements of global sea surface salinity and global carbon-dioxide atmospheric column distributions. Future missions will improve the data record that started with the Earth Observing System (EOS).

Risks to Achieving Sub-goal 3A

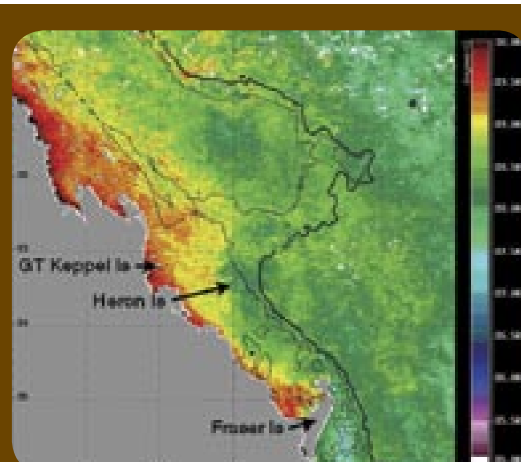
NASA planned to transition some of the observations made by EOS to the National Polar-Orbiting Operational Environment Satellite System (NPOESS), which was designed to integrate the Nation's future military, civil weather, and climate satellite systems. The NPOESS program encountered difficulties, however, leading to a slip in the scheduled launch date and removal of climate instruments from the system. As a result, termination or gaps in several key climate records are a distinct possibility.

An additional risk is associated with the slow pace of development and limited funding (both at NASA and from its domestic and international partners) for the ground-based geodetic observing networks. NASA partnered with other agencies and international partners to establish the Global Geodetic Observing System (GGOS), an international effort to study on a global scale spatial and temporal changes to the shape of Earth, its oceans, ice-covers, and land surfaces. The international partners contribute 50 percent of operating resources. GGOS also supports other applications:

NASA Helps Researchers Diagnose Coral Bleaching

NASA partnered with an international team of scientists to study the fast-acting coral bleaching plaguing Australia's Great Barrier Reef. NASA's Earth-observing satellites are providing the scientists with near-real-time sea surface temperature and ocean color data to give them insight into the impact coral bleaching can have on global ecology. In 2004, NASA scientists developed a free, Internet-based data distribution system that enables researchers around the world to customize data requests, including ocean color and sea-surface temperature data obtained by the Terra and Aqua satellites.

The Great Barrier Reef contains 2,900 reefs, 600 islands, and is a significant source of the world's marine biodiversity. However, these reefs are extremely sensitive to ocean conditions. Warmer waters force coral to expel the tiny algae that provide their color. Ultimately the lack of algae will kill the coral, destroying the reef. NASA's satellite data helps the scientists monitor temperature and color changes in the Great Barrier Reef and surrounding waters, helping protect this important natural resource.



This image of sea-surface temperatures at the southern Great Barrier Reef shows increased temperatures over in-shore reefs, the location of the most severe coral bleaching. This image was created from data from NASA's Terra and Aqua satellites. The temperatures are given in Celsius. (Univ. of Queensland)

- The precision navigation and timing for geodetic satellites, including Jason–1 and –2, the Gravity Recovery and Climate Experiment (GRACE), the Ice, Cloud, and Land Elevation satellite (ICESat), and the Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) mission;
- Navigation of interplanetary probes; and
- Alignment of telescopes and communications equipment.

NASA's ability to maintain fully this network to support both scientific research and space operations (which go beyond operations for Earth science missions) is limited. In 2006, NASA closed an important geodetic very-long baseline interferometry observatory in Fairbanks, Alaska, due to budget shortfalls. In previous years, NASA also reduced satellite laser tracking observations by 70 percent. NASA is developing a strategic plan for the development of a next-generation geodetic network to meet the needs of the scientific community. The National Research Council is reviewing the draft strategic plan as part of their decadal survey of Earth sciences and applications from space.

Current U.S. policy commits the federal government to continue collecting Landsat-type data; however, problems with aging spacecraft and delays with follow-on satellites raise concerns about a possible data gap. Launched in April 1999, Landsat–7 will deplete its fuel supply by 2010. A Landsat follow-on mission is scheduled to begin in 2012. NASA is drafting requirements for a "free flying" Landsat data continuity mission, scheduled for competitive bid in FY 2007. NASA also is working proactively with the Agency's international partners to examine other potential sources of land-cover data that can continue the availability of measurements until a Landsat follow-on is operational.

Resources, Facilities, and Major Assets

NASA develops Earth science missions either alone or with partners in the United States and around the world. NASA launches mission satellites, tracks the satellites throughout their missions, and manages data collection, distribution, and archiving. NASA also conducts an active science program that enables the use of NASA-provided data to answer scientific questions, improve predictive capability, and, through interagency partnerships, improve policy and decision-making.

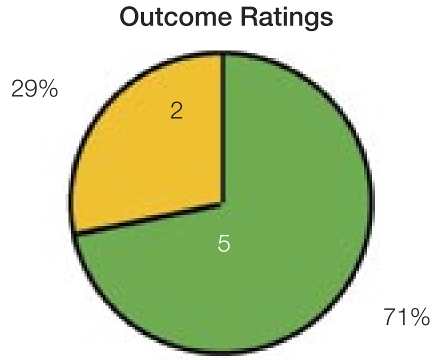
NASA's Earth Observing System Data and Information System (EOSDIS) manages and distributes data products through the Distributed Active Archive Centers. These centers process, archive, document, and distribute data from NASA's past and current research satellites and field programs. Each center serves one or more specific Earth science disciplines and provides data products, data information, services, and tools unique to its particular science. EOSDIS data products are available via the Web.

NASA's Ground Communication Networks, which include tracking stations and the Wallops Research Range control and communications, track Earth-orbiting satellites and suborbital vehicles and downlink raw data. The Distributed Active Archive Centers then process the raw data for distribution to users.

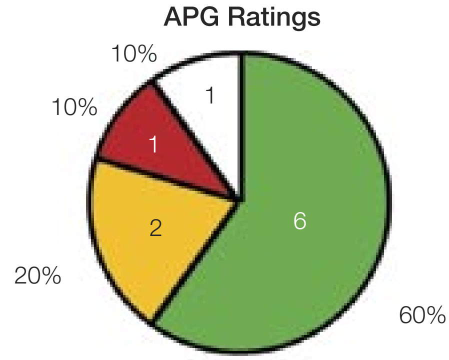
The NASA Earth Science Suborbital Science program supports the maintenance and operation of several tailored airborne platforms (including the ER–2, DC–8, WB–57F aircraft) for Earth science research. NASA and the Agency's community of investigators own and operate a broad range of scientific instrumentation, including both in-situ and remote-sensing capabilities, that use these platforms for process study, satellite calibration/validation, and integrated scientific study. In addition, NASA maintains a number of surface-based measurement networks around the world (many in conjunction with international partners) that support satellite calibration and integrated scientific activities. For example, the AERONET network maintains approximately 150 Sun photometers around the world, as well as a data center that receives, processes, and distributes the data from all. In addition, NASA operates critical components of GGOS, including ground-based systems, satellites, and data systems.

To explore the new interdisciplinary field of integrated global Earth system science, NASA uses advanced models that assimilate chemical and physical measurements—initially in the atmosphere and then in the ocean—to simulate the interactions between multiple components of the Earth system. Integrated global Earth system models are an effective tool to determine global carbon sources and sinks, the types of aerosols that increase and decrease global warming, and the important role that clouds play in global climate change.

The cost of performance for Sub-goal 3A in FY 2006 was $1,636.36 million.



Under Sub-goal 3A, NASA is on track to achieve 5 of 7 Outcomes.



Under Sub-goal 3A, NASA achieved 6 of 10 APGs.

Outcome 3A.1: Progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

Over 99.9 percent of Earth's atmosphere is a mixture of nitrogen, oxygen, and argon. Trace gases and aerosols, including pollutants from human activities, make up the remaining one-tenth percent. These gases play a critical role in atmospheric chemistry and contribute to regional and global climate changes. In FY 2006, NASA participated in and provided leadership for the Intercontinental Chemical Transport Experiment (INTEX–B), a comprehensive field campaign to study atmospheric pollutants and trace gases. INTEX–B traced the movement and evolution of pollutant gases and particles between and across continents to assess their impact on regional air quality and climate. NASA researchers coordinated observations from ground-based sites, aircraft, and NASA satellites, including Aura, Aqua, and Terra, to provide a complete picture of pollutant transport to and from the United States and to validate improved predictive capabilities for understanding changes in atmospheric composition. NASA also integrated INTEX–B findings with the National Science Foundation's Megacity Initiative: Local and Global Research Observations (MILAGRO) campaign to study air quality in the Mexico City region, as well as surrounding areas affected by the megacity's air quality.

The Cloud Absorption Radiometer (CAR) instrument is installed in the nose of a Jetstream–31 aircraft for INTEX–B. Developed at the Goddard Space Flight Center, CAR acquires imagery of cloud and Earth surface features and determines the single-scattering albedo (the reflective power) of clouds. (NASA)

In the upper portions of the atmosphere, ozone protects Earth from ultraviolet radiation. When ozone is generated near Earth's surface, however, it can be harmful to crops and human health. Ozone also acts as a greenhouse gas that can lead to climate change in specific regions. In FY 2006, scientists used the NASA Goddard Institute for Space Studies (GISS) chemistry model to trace ozone and its role in regional warming when present in Earth's upper troposphere. According to GISS findings, ozone is transported efficiently to the Arctic during fall, winter, and spring, contributing significantly to warming during these months. During the summer months, sunshine destroys the ozone before it can be transported, so regional warming occurs only over the sight of pollution.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS1 Green	For current observations, reduce the cost of acquiring and distributing the data stream to facilitate adoption by the operational community.	None	None	None
6ESS3 Green	Keep 90 percent of the total on-orbit instrument complement functional throughout the year.	None	None	None
6ESS4 Green	Mature two to three technologies to the point they can be demonstrated in space or in an operational environment and annually advance 25 percent of funded technology developments one Technology Readiness Level (TRL).	None	None	None
6ESS5 Green	Increase the number of distinct users of NASA data and services.	None	None	None
6ESS6 Yellow	Improve level of customer satisfaction as measured by a baselined index obtained through the use of annual surveys.	None	None	None
6ESS7 Green	Demonstrate progress that NASA-developed data sets, technologies and models enhance understanding of the Earth system leading to improved predictive capability in each of the six science focus area roadmaps. Progress toward achieving outcomes will be validated by external review.	None	None	None
6ESS20 Green	Systematically continue to transfer research results from spacecraft, instruments, data protocols, and models to NOAA and other operational agencies as appropriate.	None	None	None

Performance Shortfalls

6ESS6: The FY 2006 EOSDIS customer satisfaction survey produced a score of 74, a decrease from the very-high score of 78 in 2005. This score is still above the federal government average of 71.

Outcome 3A.2: Progress in enabling improved predictive capability for weather and extreme weather events.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA provides expertise, satellites, and infrastructure to develop new and improved weather forecasting capabilities for operational agencies, such as the Navy and NOAA, to issue forecasts to protect life, property, and the Nation's vital interests. Many of NASA's Earth-observation research satellites, such as the CloudSat and the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) satellites launched in April 2006, provide unprecedented views of Earth and enable scientists to study phenomena with greater scope, detail, and precision than ever before. For example, from these two missions, scientists can study the three-dimensional distribution of clouds and aerosols, enabling them to track the height of aerosol plumes around the globe. They also help scientists look at the properties of multi-layered clouds and better assess their impact on climate.

Scientists at NASA's Goddard Space Flight Center and the University of Maryland at Baltimore County used observations of cloud tops from the Tropical Rainfall Measuring Mission (TRMM) satellite to improve computer model forecasts of hurricane winds to better estimate whether a hurricane's surface winds will strengthen or weaken. This new capability has benefits for hazard mitigation and the potential to save lives and reduce property damage associated with major hurricanes.

NASA also flew the DC–8 research aircraft off the coast of West Africa as part of the Agency's contribution to the African Monsoon Multidisciplinary Analyses during summer 2006. The DC–8, outfitted as a "virtual satellite," provided the most comprehensive sampling of westward-moving waves flowing off the coast of Africa, helping to answer important but poorly understood question of how and why some of these turn into hurricanes, while others do not. The combination of in-situ and remote-sensing instruments aboard the aircraft, together with data from NASA satellites such as Terra, Aqua, Aura, CALIPSO, and CloudSat, should provide a wealth of data that can be used for scientific study over the next few years.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS1 Green	For current observations, reduce the cost of acquiring and distributing the data stream to facilitate adoption by the operational community.	None	None	None
6ESS3 Green	Keep 90 percent of the total on-orbit instrument complement functional throughout the year.	None	None	None
6ESS4 Green	Mature two to three technologies to the point they can be demonstrated in space or in an operational environment and annually advance 25 percent of funded technology developments one Technology Readiness Level (TRL).	None	None	None
6ESS5 Green	Increase the number of distinct users of NASA data and services.	None	None	None
6ESS6 Yellow	Improve level of customer satisfaction as measured by a baselined index obtained through the use of annual surveys.	None	None	None
6ESS7 Green	Demonstrate progress that NASA-developed data sets, technologies and models enhance understanding of the Earth system leading to improved predictive capability in each of the six science focus area roadmaps. Progress toward achieving outcomes will be validated by external review.	None	None	None
6ESS20 Green	Systematically continue to transfer research results from spacecraft, instruments, data protocols, and models to NOAA and other operational agencies as appropriate.	None	None	None

Performance Shortfalls

6ESS6: See Outcome 3A.1, above.

Outcome 3A.3: Progress in quantifying global land cover change and terrestrial and marine productivity, and in improving carbon cycle and ecosystem models.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA-funded scientists at the University of California, Berkeley, using an integrated global Earth system model, discovered that increased global warming over the next century will diminish the ocean's capacity to store carbon dioxide. This eventually will lead to increased levels of carbon dioxide from human activities in the atmosphere, further amplifying global warming. NASA's Orbiting Carbon Observatory (OCO) will be a key tool in characterizing the global distributions of carbon dioxide, and should enable scientists to determine its sources and sinks, yielding better understanding of the processes that control atmospheric carbon dioxide. In FY 2006, researchers completed several system reviews of the OCO spacecraft in preparation for its 2008 launch.

NASA and USGS have worked together on the Landsat program—an environmental remote sensing satellite program—since 1972 to collect and analyze data on land-cover change and use. This year, NASA-funded researchers used Landsat imagery and U.S. Census population data from 1973 to 2000 to examine for the first time the relationship between land-cover and land-use changes in the United States. Researchers learned that as of 2000, the area of exurban development (areas with housing density between one dwelling per acre and one dwelling per 40 acres) occupied nearly 15 times the area of urbanized development (areas with a housing density greater than one housing unit per acre). Exurban areas now cover 25 percent of the 48 contiguous states. Within the Mid-Atlantic and Southeastern regions, the Appalachian eco-region showed the slowest rate of land cover change. Exurban growth throughout the United States will impact future urban planning and environmental monitoring.

NASA also is assessing options for maintaining the availability of Landsat-type land-cover measurements (see "Risks to Achieving Sub-goal 3A," above, for more information).

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS1 Green	For current observations, reduce the cost of acquiring and distributing the data stream to facilitate adoption by the operational community.	None	None	None
6ESS3 Green	Keep 90 percent of the total on-orbit instrument complement functional throughout the year.	None	None	None
6ESS4 Green	Mature two to three technologies to the point they can be demonstrated in space or in an operational environment and annually advance 25 percent of funded technology developments one Technology Readiness Level (TRL).	None	None	None
6ESS5 Green	Increase the number of distinct users of NASA data and services.	None	None	None
6ESS6 Yellow	Improve level of customer satisfaction as measured by a baselined index obtained through the use of annual surveys.	None	None	None
6ESS7 Green	Demonstrate progress that NASA-developed data sets, technologies and models enhance understanding of the Earth system leading to improved predictive capability in each of the six science focus area roadmaps. Progress toward achieving outcomes will be validated by external review.	None	None	None
6ESS20 Green	Systematically continue to transfer research results from spacecraft, instruments, data protocols, and models to NOAA and other operational agencies as appropriate.	None	None	None

Performance Shortfalls

6ESS6: See Outcome 3A.1, above.

Outcome 3A.4: Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.

FY 2006	FY 2005	FY 2004	FY 2003
Yellow	None	None	None

NASA launched the CloudSat satellite in April 2006. As expected, CloudSat is able to characterize all major cloud system types, and its radar is able to penetrate all but the heaviest rainfall, enabling simultaneous imaging of storm clouds and precipitation.

During FY 2006, the Tropospheric Emission Spectrometer aboard NASA's Aura satellite yielded breakthrough observations that helped identify the primary processes and sources controlling the global water cycle in the atmosphere. By comparing the relative concentrations of different isotopic types of water vapor, scientists determined the extent of regional re-evaporation, a process where rainfall evaporates and is recycled back into clouds. The observations revealed that in tropical regions, up to 70 percent of precipitation is re-evaporated into clouds, proving that the re-evaporation process is a major component of cloud formation and energy transport.

Greenland hosts the largest reservoir of fresh water in the northern hemisphere. Any substantial changes in the mass of its ice sheet will affect global sea levels, ocean circulation, and Earth's climate system. Using data from GRACE—a mission with the unique ability to measure monthly mass changes for an entire ice sheet—NASA scientists measured a decrease in the mass of the Greenland ice cap due to melting. GRACE also detected that the thinning rate of Greenland's ice sheet (approximately 39 cubic miles a year between 2002 and 2005) is higher than previously published estimates.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS1 Green	For current observations, reduce the cost of acquiring and distributing the data stream to facilitate adoption by the operational community.	None	None	None
6ESS3 Green	Keep 90 percent of the total on-orbit instrument complement functional throughout the year.	None	None	None
6ESS4 Green	Mature two to three technologies to the point they can be demonstrated in space or in an operational environment and annually advance 25 percent of funded technology developments one Technology Readiness Level (TRL).	None	None	None
6ESS5 Green	Increase the number of distinct users of NASA data and services.	None	None	None
6ESS6 Yellow	Improve level of customer satisfaction as measured by a baselined index obtained through the use of annual surveys.	None	None	None
6ESS7 Green	Demonstrate progress that NASA-developed data sets, technologies and models enhance understanding of the Earth system leading to improved predictive capability in each of the six science focus area roadmaps. Progress toward achieving outcomes will be validated by external review.	None	None	None
6ESS20 Green	Systematically continue to transfer research results from spacecraft, instruments, data protocols, and models to NOAA and other operational agencies as appropriate.	None	None	None
6ESS22 White	Complete Global Precipitation Measurement (GPM) Confirmation Review.	None	None	None

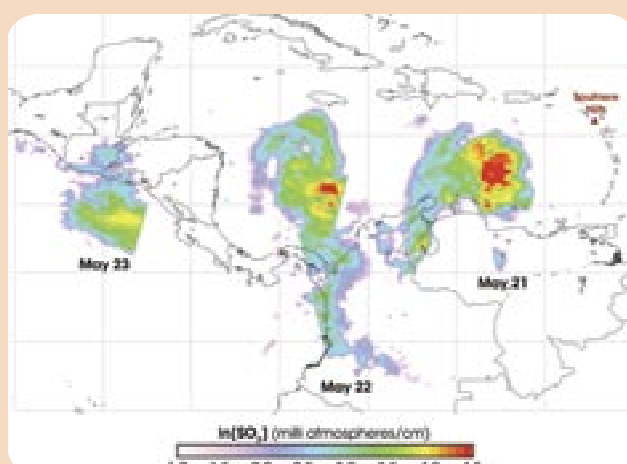
Performance Shortfalls

Outcome 3A.4: Research results in 2006 enabled progress in understanding and modeling the water cycle. However, delays in the development and launch of the Global Precipitation Measurement (GPM) mission and the NPOESS Preparatory Project (NPP) will impact NASA's progress in this science focus area.

6ESS6: See Outcome 3A.1 above.

6ESS22: NASA management deferred the GPM mission. NASA will develop an Earth science roadmap based on the mission priorities established in the decadal survey expected from the National Research Council in December 2006. The Agency will use the roadmap to re-baseline the support available to GPM by the spring of 2007.

The May 20, 2006, eruption of Soufriere Hills Volcano on Montserrat sent a cloud of ash and volcanic gas nearly 17 kilometers (55,000 feet) into the atmosphere. Intermingled with the volcanic plume was a high concentration of sulfur dioxide, measured by the AIRS instrument on Aqua. Once in the atmosphere, chemical reactions (oxidation) turn sulfur dioxide into sulfate aerosol particles that create a bright haze that reflects sunlight back into space. Since less sunlight reaches the Earth, the sulfate aerosols have a cooling effect on the climate. The effect is typically regional, but if enough of the gas reaches high into the stratosphere, the part of the atmosphere that is 20 to 50 kilometers above the surface of the Earth, temperatures around the world can drop. NASA built AIRS to help scientists gain a better understanding of weather and climate, including how gases like sulfur dioxide and the aerosols they produce impact temperatures and weather patterns. (F. Prata, Norwegian Inst. for Air Research)



Outcome 3A.5: Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.

FY 2006	FY 2005	FY 2004	FY 2003
Yellow	None	None	None

NASA funds research and satellite observations to study the dynamics between the oceans, atmosphere, and ice reservoirs. Studying the relationship of these systems improves predictions of future climate activity and increases understanding of climate processes. In FY 2006, observations from NASA's Aura satellite showed that when a sea surface temperature exceeds about 80 degrees Fahrenheit, water evaporated from the warm surface is carried to the upper atmosphere through the formation of towering cumulus clouds (or thunderheads). This warm water vapor eventually evaporates ice particles in the high-altitude clouds, leaving increased water vapor concentrations in the upper atmosphere. This finding indicates that the cloud-induced moistening of the tropical upper troposphere leads to about three times more water vapor output than is expected in the absence of the clouds.

Scientists at NASA's Jet Propulsion Laboratory used satellite observations to measure the complete cycle of atmospheric water movement over the South American continent, ocean to ocean. Using data from NASA's QuikScat, GRACE, and TRMM satellites, researchers confirmed that the amount of atmospheric water flowing into the continent as rain and snow was equal to the amount of water returned to the ocean by rivers. This finding represents the first direct observations of the seasonal cycle of continental water balance.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS1 Green	For current observations, reduce the cost of acquiring and distributing the data stream to facilitate adoption by the operational community.	None	None	None
6ESS3 Green	Keep 90 percent of the total on-orbit instrument complement functional throughout the year.	None	None	None
6ESS4 Green	Mature two to three technologies to the point they can be demonstrated in space or in an operational environment and annually advance 25 percent of funded technology developments one Technology Readiness Level (TRL).	None	None	None
6ESS5 Green	Increase the number of distinct users of NASA data and services.	None	None	None
6ESS6 Yellow	Improve level of customer satisfaction as measured by a baselined index obtained through the use of annual surveys.	None	None	None
6ESS7 Green	Demonstrate progress that NASA-developed data sets, technologies and models enhance understanding of the Earth system leading to improved predictive capability in each of the six science focus area roadmaps. Progress toward achieving outcomes will be validated by external review.	None	None	None
6ESS20 Green	Systematically continue to transfer research results from spacecraft, instruments, data protocols, and models to NOAA and other operational agencies as appropriate.	None	None	None
6ESS23 Red	Complete Operational Readiness Review for the NPOESS Preparatory Project (NPP).	None	None	None

Performance Shortfalls

Outcome 3A.5: Cost overruns and technical difficulties delayed the NPOESS Preparatory Project (NPP) mission, which will impact NASA's progress in this science focus area. Program funding supports the NPP 2009 launch date.

6ESS6: See Outcome 3A.1 above.

6ESS23: Due to late delivery of the key Visible/Infrarerd Imager/Radiometer Suite (VIIRS) instrument from a program partner, NASA moved the Operational Readiness Review for NPP to September 2009.

Outcome 3A.6: Progress in characterizing and understanding Earth surface changes and variability of Earth's gravitational and magnetic fields.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

The measurements of changes in the gravity field over time from the GRACE mission yielded the first uniform mass balance estimates for the Greenland and Antarctic polar ice caps, indicating significant and perhaps accelerating loss of ice mass. During FY 2006, the GRACE mission also yielded other results:

- Circum-Antarctic deep-ocean current variability;
- Regional water accumulation data demonstrating that algorithms show continual improvement for estimating biweekly to multi-year trends and periodicities in water storage over land regions, from continental areas to regional drainage basins;
- The first complete signature of land surface displacements due to a major earthquake; and
- Observations showing that the movement of the ocean floor resulting from the Aceh Earthquake of December 2004 caused a gravity change on Earth. This is the first observation of the stretching within Earth's crust caused by an undersea earthquake. The finding indicates that GRACE's measurements will provide a new global capability to enhance understanding of the release of stress by large earthquakes.

NASA continues to support the measurement of Earth's magnetic field variability. For example, the European Space Agency's satellite constellation, Swarm (to be launched in 2009), uses a NASA-developed, comprehensive model for geomagnetic modeling. NASA also supports the measurement of ultra-low-frequency electromagnetic signals in California to study possible earthquake precursors.

In July 2006, NASA announced progress in understanding earthquake causes and effects with the development of a rapid earthquake-magnitude evaluation technique that reduces the time needed to determine the magnitude of large earthquakes from hours to minutes. The system is crucial to identifying possible tsunami-producing earthquakes, enabling early activation of disaster response teams. The system builds on the NASA-developed, real-time GPS precision positioning capability, which can feed data into the real-time tsunami modeling system being developed by NOAA. The USGS also has expressed interest in working with NASA to develop a similar capability to augment its seismometer-based networks. The real-time GPS capability also could be deployed aboard ocean buoys to aid in detecting passing tsunamis.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS1 Green	For current observations, reduce the cost of acquiring and distributing the data stream to facilitate adoption by the operational community.	None	None	None
6ESS3 Green	Keep 90 percent of the total on-orbit instrument complement functional throughout the year.	None	None	None
6ESS4 Green	Mature two to three technologies to the point they can be demonstrated in space or in an operational environment and annually advance 25 percent of funded technology developments one Technology Readiness Level (TRL).	None	None	None
6ESS5 Green	Increase the number of distinct users of NASA data and services.	None	None	None
6ESS6 Yellow	Improve level of customer satisfaction as measured by a baselined index obtained through the use of annual surveys.	None	None	None
6ESS7 Green	Demonstrate progress that NASA-developed data sets, technologies and models enhance understanding of the Earth system leading to improved predictive capability in each of the six science focus area roadmaps. Progress toward achieving outcomes will be validated by external review.	None	None	None

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS20 Green	Systematically continue to transfer research results from spacecraft, instruments, data protocols, and models to NOAA and other operational agencies as appropriate.	None	None	None

Performance Shortfalls

6ESS6: See Outcome 3A.1, above.

OUTCOME 3A.7: PROGRESS IN EXPANDING AND ACCELERATING THE REALIZATION OF SOCIETAL BENEFITS FROM EARTH SYSTEM SCIENCE.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA's Applied Science Program collaborates with other federal agency partners to expand their use of NASA Earth science research results. The Applied Science Program activities provide innovative benefits to the Nation in 12 focus areas: Agricultural Efficiency, Air Quality, Aviation, Carbon Management, Coastal Management, Disaster Management, Ecological Forecasting, Energy Management, Homeland Security, Invasive Species, Public Health, and Water Management. In FY 2006, the program made progress toward this Outcome through 147 funded activities that yielded results in all 12 focus areas. One project included an evaluation of the NOAA Harmful Algal Blooms Observation System prototype, which will alert coastal management officials when populations of phytoplankton (i.e., harmful algal blooms) grow out of control, threaten coastal ecosystems, or pose hazards to human health. The program also validated a prototype system that integrates NASA Earth science results into the Center for Disease Control (CDC)-sponsored ArboNET/Plague Surveillance System. This CDC system tracks insect populations that carry and transmit disease-producing microorganisms. NASA data and infrastructure support through the Regional Visualization and Monitoring System (SERVIR) Program also improved ecological forecasting and disaster management in Central America. NASA research enhanced aviation weather-hazard nowcasting (forecasting in a zero- to six-hour timeframe) and improved short-term forecasting products developed by the Federal Aviation Administration. NASA's research also improved global crop monitoring performed by the U.S. Department of Agriculture.

The National Research Council is evaluating NASA's progress toward this Outcome.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS1 Green	For current observations, reduce the cost of acquiring and distributing the data stream to facilitate adoption by the operational community.	None	None	None
6ESS21 Yellow	Benchmark the assimilation of observations and products in decision support systems serving applications of national priority. Progress will be evaluated by the Committee on Environmental and National Resources.	None	None	None

Performance Shortfalls

6ESS21: NASA completed this benchmarking in support of such areas as agricultural efficiency, air quality, aviation, disaster management, and public health. However, the external evaluation was postponed, primarily due to delays related to committee members' schedules.

Sub-goal 3B *Understand the Sun and its effects on Earth and the solar system.*

Life on Earth is linked to the behavior of the Sun. The Sun's energy output is fairly constant when averaged over thousands of years, yet highly variable on an 11-year cycle. Moreover, short-term events like solar flares and coronal mass ejections (CMEs) can change drastically solar emissions over the course of a single second. All of the solar system's planets orbit within the outer layers of the Sun's atmosphere, and some planetary bodies, like Earth, have an atmosphere and magnetic field that interacts with solar wind. While Earth's magnetic field protects life, it also acts as a battery, storing energy from solar wind until it is released, producing "space weather" that can disrupt communications, navigation, and power grids, damage satellites, and threaten the health of astronauts.

A technician readies a high-gain antenna for vibration testing at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, in late 2005. This antenna later was attached to the STEREO "A" observatory at the Goddard Space Flight Center. NASA will launch STEREO in early FY 2007. (NASA/JHU–APL)

NASA researchers study the Sun and its influence on the solar system as elements of a single, interconnected Sun–Earth system using a group of satellites that form the Heliophysics Great Observatory. NASA seeks to understand the fundamental physics behind Sun–planet interactions and use this information to protect humans and electronics in space and on Earth. NASA also studies specific space environmental hazards to help the Agency design, build, and operate safe and stable exploration spacecraft.

Risks to Achieving Strategic Sub-goal 3B

Most of the missions that make up the multi-national Heliophysics Great Observatory, including the Solar and Heliospheric Observatory (SOHO), Voyagers 1 and 2, and the Fast Auroral Snapshot Explorer (FAST), are past their initial design life and starting to show signs of age. Some satellites already have fallen victim to age. For example, the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE), which was designed for a two-year mission, failed in FY 2006 after almost six years of successful operation. By operating this group of spacecraft as a single observational system, researchers can collect data for a variety of models to fill observational gaps and provide predictions of tomorrow's space weather. NASA plans to launch new missions in FY 2007 to refresh the Heliophysics Great Observatory: the Solar Terrestrial Relations Observatory (STEREO), the Aeronomy of Ice in the Mesosphere (AIM), and the Time History of Events and Macroscale Interactions (THEMIS) mission. The joint NASA–Japanese Aerospace Exploration Agency Solar–B mission, now called Hinode (or "sunrise" in Japanese), launched from Japan on September 22, 2006. However, NASA's ability to launch future small, less-expensive missions is threatened by the rising cost of smaller launch vehicles and escalating development costs. An inability to sustain new heliophysics missions could create capability gaps for the Heliophysics Great Observatory.

Resources, Facilities, and Major Assets

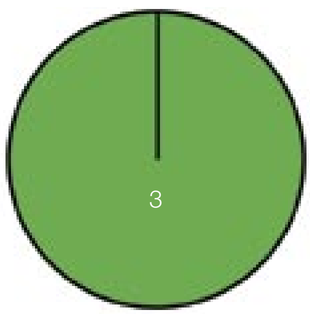
NASA's fleet of operational satellites, as well as missions currently in development, are the greatest assets contributing to the successful achievement of Sub-goal 3B. These satellites represent considerable investments in time, money, and workforce skills by NASA and partners across the country and around the world.

NASA's Heliophysics Data Environment—a standardized, electronic tool to collect, store, manage, and distribute Sun–Earth mission data—harnesses the full benefit of heliophysics science conducted by NASA and program partners. The project uses Virtual Observatories that link together the world's science community and available astronomy and astrophysics data using computer technology. In FY 2006, NASA added five new Virtual Observatories to the Heliophysics Data Environment.

All NASA space science data is archived permanently by the National Space Science Data Center (NSSDC), located at the Goddard Space Flight Center. NSSDC's Space Physics Data Facility hosts an archive that consists of Web-based services for survey and high-resolution data, trajectories, and modeling software. The facility delivers value-added services and leads in the definition, development, operation, and promotion of collaborative projects.

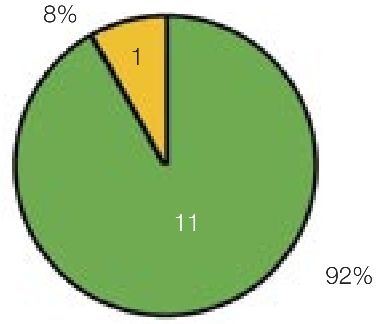
The cost of performance for Sub-goal 3B in FY 2006 was $974.71 million.

Outcome Ratings



Under Sub-goal 3B, NASA is on track to achieve all 3 Outcomes.

APG Ratings



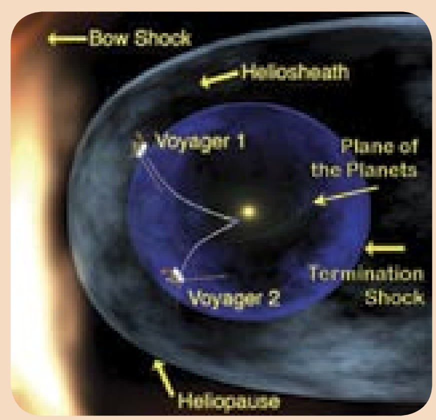
Under Sub-goal 3B, NASA achieved 11 of 12 APGs.

Outcome 3B.1: 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.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

Understanding how space weather originates and evolves is the first step toward predicting space weather events that pose a potential threat to Earth and space explorers. In FY 2006, NASA researchers identified sources of solar energetic particles, observed variations in the thickness of the Sun's atmosphere in connection with the 11-year solar cycle, and found evidence that solar flare-accelerated ions and electrons may originate from separate locations.

Most of the planets in the solar system orbit along a similar plane, almost like they were sitting on a table around the Sun. As the two Voyager spacecraft journeyed beyond the planets, Voyager 1 flew "north" (above the plane) and Voyager 2 flew "south" (below the plane), as shown in this illustration. During FY 2006, Voyager 2 discovered that the termination shock (shown in bright blue) is 840 million miles closer to the Sun in the south than observed by Voyager 1 in the north. As a result, Voyager 2 will cross the termination shock a year earlier than expected. Voyager 1 crossed the termination shock in FY 2005. (NASA)



Below the plane of the planets, the Voyager 2 spacecraft observed evidence of the solar system's termination shock—the shock wave that forms as solar wind reaches the boundary between the edge of the solar system and interstellar space—at a distance of about 840 million miles closer to the Sun than observed by Voyager 1 in the north. This difference shows a distortion in the shape of the heliosphere—the giant magnetic bubble containing the solar system—likely resulting from an inclined interstellar magnetic field pressing inward on the heliosphere from the south. The compressed shape of the heliosphere in the south means that Voyager 2 probably will cross the termination shock a year ahead of expectations, joining Voyager 1 in exploring the heliosheath, the final frontier of the solar system.

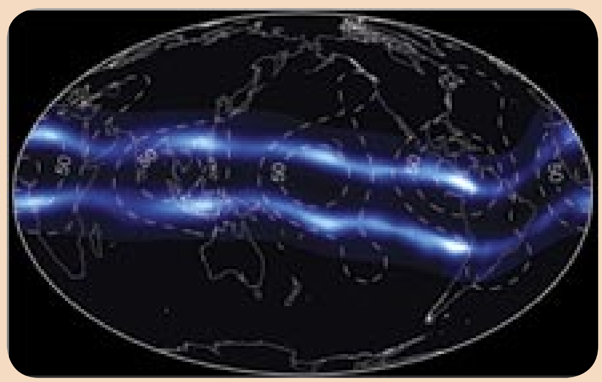
FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS11 Green	Successfully demonstrate progress in understanding the structure and dynamics of the Sun and solar wind and the origins of solar variability. Progress toward achieving outcomes will be validated by external expert review.	5SEC9 Blue	4SEC11 Green	3S7 Green
6ESS12 Green	Successfully demonstrate progress in determining the evolution of the heliosphere and its interaction with the galaxy. Progress in achieving outcomes will be validated by external expert review.	None	None	None
6ESS14 Green	Successfully demonstrate progress in discovering how magnetic fields are created and evolve and how charged particles are accelerated. Progress in achieving outcomes will be validated by external expert review.	5SEC12 Blue	4SEC14 Green	None
6ESS15 Green	Successfully demonstrate progress in understanding coupling across multiple scale lengths and its generality in plasma systems. Progress in achieving outcomes will be validated by external expert review.	5SEC13 Green	4SEC15 Green	None
6ESS17 Green	Complete the Solar Dynamics Observatory (SDO) spacecraft structure and begin Integration and Test (I&T).	5SEC2 Green	None	None
6ESS18 Green	Initiate Geospace Phase A studies.	White	None	None

Outcome 3B.2: Progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

In FY 2006, NASA advanced the understanding of both short- and long-term variations in solar emissions. This is important progress because these emissions can increase densities in Earth's ionosphere and produce magnetic storms within Earth's magnetosphere that occasionally disable satellites, power grids, and other critical technologies. In FY 2006, NASA developed a new model that allows researchers to fly virtual satellites through simulations of Earth's Van Allen Belts, radiation belts of high-energy particles (mainly protons and electrons) held captive by the magnetic influence of Earth. The model shows how high-energy particles trapped in the belts would affect optical and thermal coatings as the virtual satellite orbits through a selected region. The results will help NASA select coatings based on a satellite's planned orbit, giving satellites additional protection from the effects of destructive high-energy particles throughout its mission.

NASA has shown that the impact of the Sun on space weather around Earth is different for dense clouds of solar material than for long high-speed streams of gas. Space storms triggered by magnetic clouds tend to be brief, and produce new, transient radiation belts, great auroras, and disruptive ground currents. Space storms triggered by high-speed streams are longer in duration, more likely to



During FY 2006, weather on Earth was found to have a surprising connection to space weather in the electrically charged upper atmosphere, or ionosphere. This discovery will help improve forecasts of turbulence in the ionosphere, which can disrupt radio signals from satellites including communications satellites and the Global Positioning System. Using pictures from IMAGE, the team discovered four mysteriously bright regions in the Appleton Anomalies that were 20 to 30 percent denser than average. Three of these bright zones were located over tropical rainforests with lots of storm activity: the Amazon Basin in South America, the Congo Basin in Africa, and Indonesia. A fourth region appeared over the Pacific Ocean. Researchers confirmed that thunderstorms over the three tropical rainforest regions produce rising tides of hot air that were altering the structure of the ionosphere. (NASA) affect spacecraft, and produce more intense radiation belts. Studies of these differences are important to understanding the effects of solar events on the Earth system.

The charged particles (or plasma) trapped in the Van Allen Belts are drained continuously and replenished through dynamic interactions between the Sun and Earth. This interaction can alter the size and intensity of the radiation belts, creating space weather that affects directly the performance of satellites. NASA has discovered how one of these processes replenishes the high-energy radiation in the belts. NASA research revealed how low-frequency electromagnetic waves quickly accelerate plasma in the radiation belts. These waves, which are common in the boundary between the radiation belts and the cold, dense plasma from the upper ionosphere, are a primary source for replenishing the radiation belts.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS8 Green	Successfully demonstrate progress in developing the capability to predict solar activity and the evolution of solar disturbances as they propagate in the heliosphere and affect the Earth. Progress toward achieving outcomes will be validated by external expert review.	5SEC6 Green	4SEC8 Green	3S7 Green
6ESS9 Green	Successfully demonstrate progress in specifying and enabling prediction of changes to the Earth's radiation environment, ionosphere, and upper atmosphere. Progress toward achieving outcomes will be validated by external expert review.	5SEC7 Green	4SEC9 Green	3S8 Green
6ESS10 Green	Successfully demonstrate progress in understanding the role of solar variability in driving space climate and global change in the Earth's atmosphere. Progress toward achieving outcomes will be validated by external expert review.	5SEC8 Green	4SEC10 Blue	None
6ESS13 Green	Successfully demonstrate progress in understanding the response of magnetospheres and atmospheres to external and internal drivers. Progress in achieving outcomes will be validated by external expert review.	5SEC11 Green	4SEC13 Green	None
6ESS16 Yellow	Successfully launch the Solar Terrestrial Relations Observatory (STEREO).	5SEC1 Yellow	None	None
6ESS17 Green	Complete the Solar Dynamics Observatory (SDO) spacecraft structure and begin Integration and Test (I&T).	5SEC2 Green	None	None
6ESS18 Green	Initiate Geospace Phase A studies.	5SEC4 White	None	None
6ESS19 Green	Publish Solar Sentinels Science Definition Team report.	None	None	None

Performance Shortfalls

6ESS16: NASA postponed the STEREO mission launch due to problems with the Delta II launch vehicle second-stage tanks.

Outcome 3B.3: Progress in developing the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

To safeguard astronauts and robotic assets in space, researchers must characterize the extremes and variability of solar-induced events. The SOHO team made progress toward predicting potentially harmful solar events during FY 2006 by watching for wave motions excited in the Sun's interior that are indicative of areas of high activity. This new method allows scientists to see almost the entire far side of the Sun. Since the Sun rotates every 27 days relative to Earth, a solar flare could erupt around the horizon at any time. This new method for monitoring the entire surface of the Sun will provide early warning of solar events, helping NASA protect astronauts in space.

Scientists supporting NASA's Living with a Star Program created a new model of the Sun's dynamo, which described the peaks of the last eight solar cycles, that has promise for predicting future solar-cycle activity. If successful, this model will allow NASA to plan for future high-activity cycles and protect human and robotic explorers. NASA also developed a simulation of the slowly evolving solar corona that can predict conditions that could produce CMEs. CMEs occur when a magnetic field under stress snaps, releasing billions of pounds of accelerated plasma, charged particles that can damage electronics and harm unprotected astronauts. In March 2006, NASA testing showed that the model could successfully predict the structure and appearance of the corona during a total solar eclipse.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESS16 Yellow	Successfully launch the Solar Terrestrial Relations Observatory (STEREO).	5SEC1 Yellow	None	None
6ESS17 Green	Complete the Solar Dynamics Observatory (SDO) spacecraft structure and begin Integration and Test (I&T).	5SEC2 Green	None	None
6ESS18 Green	Initiate Geospace Phase A studies.	5SEC4 White	None	None
6ESS19 Green	Publish Solar Sentinels Science Definition Team report.	None	None	None

Performance Shortfalls

6ESS16: See Outcome 3B.2 above.

NASA's ST-5 Satellites Push Technological Boundaries

In FY 2006, NASA tested an innovative technology for micro-satellites that operate as a group. Space Technology 5 (ST5), a group of three spacecraft, was launched from a modified Pegasus XL rocket on March 22, 2006. Each satellite weighed about 55 pounds and was the size of a birthday cake. After launching, the micro-satellites positioned themselves in a "string of pearls" constellation, approximately 25 to 90 miles apart.

Despite their small size, these satellites came fully loaded and carried a scientific payload that mapped the intensity and direction of magnetic fields within the inner magnetosphere. The main goal of the mission was to demonstrate the benefits of a group of small, low-cost spacecraft taking measurements at the same time in different locations. ST5 helped NASA learn how to build efficiently identical micro-satellites, shortening development time and lowering costs for future micro-satellite missions. ST5 stopped operations on June 30, 2006, after a successful 90-day mission.

Engineers build one of three ST5 micro-satellites at the Goddard Space Flight Center. NASA then shipped the micro-satellites to Vandenberg Air Force Base, California, for testing and launch. (NASA)

Sub-goal 3C *Advance scientific knowledge of the solar system, search for evidence of life, and prepare for human exploration.*

NASA's robotic science missions are paving the way for human space exploration by studying and characterizing alien environments, identifying possible resources, validating new capabilities, and delivering the infrastructure that will enable safe and effective human missions.

Robotic explorers also gather data to help scientists understand how the planets formed, what triggered different evolutionary paths among planets, and how Earth originated, evolved, and became habitable. To search for evidence of life beyond Earth, scientists use this data to map zones of habitability, study the chemistry of alien worlds, and unveil the processes that lead to conditions necessary for life. Moreover, NASA scientists gain knowledge from robotic exploration that provides valuable insight into the nature of life on Earth.

Knowledge about the solar system helps protect life on Earth. For example, through the Near Earth Object Observation Program, NASA identifies and categorizes near-Earth objects (e.g., asteroids and comets) that could threaten life on Earth.

Risks to Achieving Sub-goal 3C

Interplanetary spacecraft for solar system exploration are expensive and complex and often require long lead-times for planning and development. Once launched, the travel times to the spacecraft's destinations may take months or years.

Assessments

In FY 2006, the Office of Management and Budget (OMB) assessed the Solar System Exploration Theme with OMB's Program Assessment Rating Tool (PART). OMB assessed the overall program as "Effective," the highest rating available, with the following scores by rating area:

- Program Purpose and Design—100%
- Strategic Planning—100%
- Program Management—91%
- Program Results/Accountability—80%

The lower scores under Program Management and Program Results/Accountability were due to on-going issues with Agency-wide financial management practices and minor programmatic slips. NASA is making progress in improving the Agency's financial management system.

Resources, Facilities, and Major Assets

NASA's progress toward achieving Sub-goal 3C rests on the success of numerous planetary science orbiters, solar system probes, rovers, landers, and sample return missions. These missions are supported by laboratories at NASA Centers, including the Goddard Space Flight Center and the Jet Propulsion Laboratory, and at universities around the country. These laboratories provide years—and occasionally decades—of mission management, data collection, and analysis. Some missions, including Cassini/Huygens and Rosetta, are joint projects between NASA and international partners.

NASA's Planetary Data System (PDS) archives data by areas—atmospheres, geosciences, imaging, planetary plasma interactions, and small bodies—and makes data available to the planetary sciences community. Mission principal investigators comply with PDS standards to ensure the integrity and long-term usability of datasets. PDS is managed by NASA's National Space Science Data Center, the permanent archive for all NASA space science data, located at the Goddard Space Flight Center. NASA also supports extraterrestrial sample curation (storage and oversight of material returned from space) at the Johnson Space Center.

The cost of performance for Sub-goal 3C in FY 2006 is $1,948.93 million.

Stardust Samples Amaze Scientists

NASA's Stardust mission to explore comet Wild 2 successfully returned to Earth in a picture perfect landing on January 15, 2006. The spacecraft collected samples of gas and dust from the comet. "Ten years of planning and seven years of flight operations were realized early this morning when we successfully picked up our return capsule off of the desert floor in Utah," said Tom Duxbury, Stardust project manager at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "The Stardust project has delivered to the international science community material that has been unaltered since the formation of our solar system."

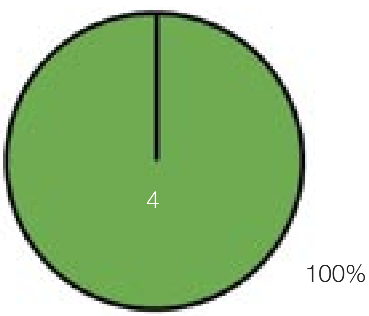
In March, scientists discovered that dust samples from the comet unexpectedly contained mineral particles, such as Olivine, formed under high temperatures not usually associated with the frigid region known as the Kuiper belt where Wild 2 orbits. This finding alters the traditional view that comets are made of ice and dust composed largely of interstellar material gathered on the outskirts of the solar system. Instead, the finding suggests that the Sun may have spewed particles outward as its dusty disk, which eventually formed the solar system, swirled inward around the Sun like water circling a drain.

Stardust collected massive quantities of dust samples within each aerogel chamber. Due to the sample size, NASA and the Planetary Society posted photos from an automatic scanning microscope of the samples to the Stardust@home Web site and encouraged volunteers to search the photos for dust samples. Over 115,000 aspiring stardust hunters have pre-registered to search these photos.

Above: Donald Brownlee, Stardust principal investigator with the University of Washington, flashes a victory sign for the successful arrival of Stardust material at the Johnson Space Center in January 2006. (NASA)

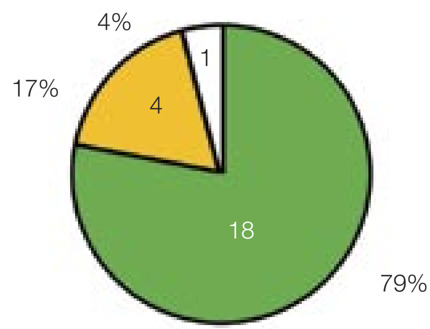
Left: Comet particles are trapped in aerogel in this photo taken of a Stardust sample. (NASA/JPL)

Outcome Ratings



Under Sub-goal 3C, NASA is on track to achieve all 4 Outcomes.

APG Ratings



Under Sub-goal 3C, NASA achieved 18 of 23 APGs.

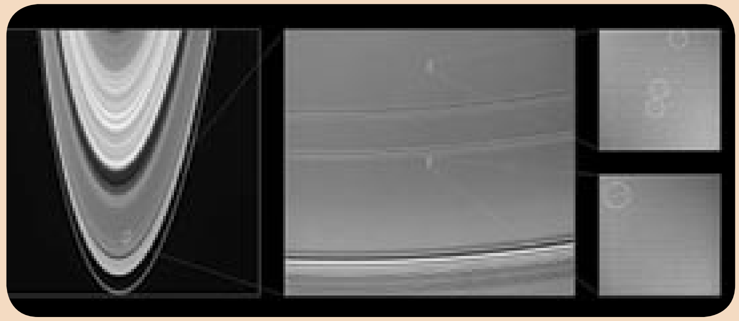
Outcome 3C.1: Progress in learning how the Sun's family of planets and minor bodies originated and evolved.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

Images from the Cassini spacecraft proved the existence of tiny "moonlets" in Saturn's rings—perhaps as many as 10 million within one of Saturn's rings alone. The moonlets' existence could help researchers determine if Saturn's rings formed as a result of a cataclysmic break-up of an orbiting body or if they are composed of the remnants from the disk of material that formed Saturn and its moons.

In a related finding, NASA researchers used the Hubble Space Telescope to image Uranus' ring system and discovered a dynamic interaction between meteoroids, Uranus' moons, and the planet's dusty rings. The Hubble images

Careful analysis of the highest-resolution images taken by Cassini's cameras as the spacecraft slipped into Saturn orbit revealed the four faint, propeller-shaped double-streaks in an otherwise bland part of the mid–A ring. Imaging scientists believe the "propellers" are the first direct observation of the dynamical effects of small moonlets, approximately 100 meters (300 feet) in diameter. These moonlets represent a hitherto unseen size-class of particles orbiting within the rings. The propellers are about 5 kilometers (3 miles) long from tip to tip, and the radial offset (the "leading" dash is slightly closer to Saturn) is about 300 meters (1,000 feet). (NASA/JPL/Space Science Institute)



revealed that meteoroids continually impact Uranus' moons, providing fresh dust and replenishing the rings, which are depleted through gravitational forces. This chaotic process of replenishing helps explain how planetary systems may have formed.

For the first time, Hubble imaged the dwarf planet Eris (formerly known as the 10th planet, or Xena) and found that it is only slightly larger than Pluto. Eris is 10 billion miles from Earth with a diameter a little more than half the width of the United States, but it is one of the brightest, most reflective objects in the solar system, possibly due to fresh methane frost on its surface.

New discoveries, like the dwarf planet Eris, the binary nature of Pluto and Charon, and other dwarf planetoids in the Kuiper belt, have ignited a heated debate among astronomers concerning the taxonomy of planets and fueled an investigation into the role of minor planets in the solar system. In January 2006, NASA launched the New Horizons spacecraft on a nine-year trip to Pluto. Data collected from New Horizons will help scientists understand the processes of planet formation and clarify the differences, if any, between planets and planetoids.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SSE7 Green	Successfully demonstrate progress in understanding the initial stages of planet and satellite formation. Progress toward achieving outcomes will be validated by external expert review.	5SSE7 Green	4SSE12 Yellow	None
6SSE8 Green	Successfully demonstrate progress in understanding the processes that determine the characteristics of bodies in our solar system and how these processes operate and interact. Progress toward achieving outcomes will be validated by external expert review.	5SSE8 Blue	4SSE13 Green	3S3 Green
6SSE10 Green	Successfully demonstrate progress in learning what our solar system can tell us about extra-solar planetary systems. Progress toward achieving outcomes will be validated by external expert review.	5SSE10 Blue	4SSE15 Green	None
6SSE11 Green	Successfully demonstrate progress in determining the nature, history, and distribution of volatile and organic compounds in the solar system. Progress toward achieving outcomes will be validated by external expert review.	5SSE11 Green	4SSE16 Green	None
6SSE26 Green	Successfully return Stardust science samples to Earth.	None	None	None
6SSE27 Yellow	Successfully launch Dawn spacecraft.	None	None	None
6SSE28 White	Successfully complete MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) flyby of Venus.	None	None	None

Performance Shortfalls

6SSE27: NASA postponed the Dawn mission launch until June 2007 due to technical delays and cost issues. The mission will study the dwarf planets Ceres and Vesta.

6SSE28: NASA erroneously included this APG in the FY 2006 Performance Plan. MESSENGER's scheduled flyby of Venus is October 23, 2006 (FY 2007).

Outcome 3C.2: Progress in understanding the processes that determine the history and future of habitability in the solar system, including the origin and evolution of Earth's biosphere and the character and extent of prebiotic chemistry on Mars and other worlds.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA's Cassini spacecraft discovered liquid water reservoirs that erupt like geysers on Saturn's moon, Enceladus. These water plumes continuously recoat the moon's surface with highly reflective ice, making it one of the brightest objects in the solar system. The rare occurrence of liquid water so near the surface raises new questions about this mysterious moon and the solar system. If Cassini's discovery is correct, the solar system could be more diverse than previously theorized, possibly including environments suitable for life. Other moons in the solar system have liquid water oceans covered by kilometers of icy crust, but the pockets of liquid water on Enceladus may be just meters below the surface. NASA plans further observations in the spring of 2008 when the Cassini spacecraft will fly within 350 kilometers (about 220 miles) of Enceladus.

On Mars' surface, Mars Exploration Rovers, *Spirit* and *Opportunity*, continue to function, gathering a full Martian year data-set that provides detailed daily and seasonal changes in weather, temperature, and dust devil action. *Spirit* and *Opportunity* also collected geological data that revealed part of Mars' past environment, including evidence for the presence of water.

MRO spotted the long-lived *Opportunity* rover as it explored the edge of Victoria Crater. The level of detail in the photo from the high-resolution camera on MRO will help guide the rover's exploration of Victoria. Images from NASA's Mars Global Surveyor, orbiting the Red Planet since 1997, prompted the rover team to choose Victoria two years ago as the long-term destination for *Opportunity*. Exposed geological layers in the cliff-like portions of Victoria's inner wall appear to record a longer span of Mars' environmental history than similar strata that the rover has studied in smaller craters. Victoria is five times larger than any crater *Opportunity* has visited during its Martian trek. (NASA/JPL/UA)

In August 2006, the Mars Odyssey spacecraft completed its first extended mission to study the Martian surface and its geochemical composition. In addition to assessing the abundance of water, the Gamma-Ray Spectrometer suite onboard Odyssey collected data on the variations in atmospheric argon, traced the planetary carbon-dioxide cycle, and mapped the global distribution of important rock-forming elements, including iron, chlorine, silicon, potassium, and thorium.

NASA's Mars Reconnaissance Orbiter (MRO) achieved its science orbit on September 12, 2006, and began deploying its antenna and removing lens caps from its instruments. It will begin main science investigations in November. MRO is equipped with the Mars Climate Sounder, which will continually measure the structure of the Martian atmosphere, and the Mars Color Imager, which will provide daily global coverage of the weather. MRO's high-resolution imagers will track evidence of the history and distribution of water on Mars and identify potential future sites for exploration.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SSE9 Yellow	Successfully demonstrate progress in understanding why the terrestrial planets are so different from one another. Progress toward achieving outcomes will be validated by external expert review.	5SSE9 Yellow	4SSE14 Green	3S5 Green

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SSE12 Green	Successfully demonstrate progress in identifying the habitable zones in the solar system. Progress toward achieving outcomes will be validated by external expert review.	5SSE12 Green	4SSE17 Green	3S6 Green
6SSE13 Green	Successfully demonstrate progress in identifying the sources of simple chemicals that contribute to prebiotic evolution and the emergence of life. Progress toward achieving outcomes will be validated by external expert review.	5SSE13 Green	4SSE18 Green	3S6 Green
6SSE14 Green	Successfully demonstrate progress in studying Earth's geologic and biologic records to determine the historical relationship between Earth and its biosphere. Progress toward achieving outcomes will be validated by external expert review.	5SSE14 Green	4SSE19 Green	3S6 Green
6SSE15 Green	Successfully demonstrate progress in characterizing the present climate of Mars and determining how it has evolved over time. Progress toward achieving outcomes will be validated by external expert review.	5MEP7 Green	4MEP9 Green	None
6SSE16 Green	Successfully demonstrate progress in understanding the history and behavior of water and other volatiles on Mars. Progress toward achieving outcomes will be validated by external expert review.	5MEP8 Blue	4MEP10 Blue	None
6SSE17 Green	Successfully demonstrate progress in understanding the chemistry, mineralogy, and chronology of Martian materials. Progress toward achieving outcomes will be validated by external expert review.	5MEP9 Green	4MEP11 Blue	None
6SSE18 Green	Successfully demonstrate progress in determining the characteristics and dynamics of the interior of Mars. Progress toward achieving outcomes will be validated by external expert review.	5MEP10 Green	4MEP12 Green	None
6SSE19 Yellow	Successfully demonstrate progress in understanding the character and extent of prebiotic chemistry on Mars. Progress toward achieving outcomes will be validated by external expert review.	5MEP11 Yellow	4MEP13 Green	None
6SSE25 Green	Complete Mars Science Laboratory Preliminary Design Review (PDR).	5MEP4 Yellow	None	None

Performance Shortfalls

6SSE9: External reviewers deemed all of the evidence presented for this APG as positive. However, since the evidence was based on preliminary results, the external reviewers rated the progress on this goal as less robust than the progress seen in other areas of planetary science.

6SSE19: The lack of direct measurements has limited NASA's progress in this area. The next two Mars missions, Phoenix and the Mars Science Laboratory, have the technology to measure directly organic compounds and potentially elucidate the character and extent of pre-biotic chemistry.

Outcome 3C.3: Progress in identifying and investigating past or present habitable environments on Mars and other worlds, and determining if there is or ever has been life elsewhere in the solar system.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

After several months of aerobraking, during which a spacecraft uses friction from a planet's atmosphere to adjust its orbit, MRO achieved its science orbit in September 2006 and prepared to begin main science investigations in November. MRO's instruments will search for chemical and biological indications that the Red Planet had once—or still does—support life.

Data from *Spirit* and *Opportunity* show that specific epochs of Martian history were wet, strongly acidic, and oxidizing—an environment not conducive to the development of life on Mars. However, the recent discovery of liquid water on Enceladus suggests that habitable environments may exist elsewhere in the solar system. Further exploration is necessary to identify and characterize these new environments.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SSE20 Yellow	Successfully demonstrate progress in searching for chemical and biological signatures of past and present life on Mars. Progress toward achieving outcomes will be validated by external expert review.	5MEP12 Green	4MEP14 Green	3S6 Green

Performance Shortfalls

6SSE20: The current missions at Mars, though providing data, do not possess technology to address this APG. The next two Mars missions, Phoenix and the Mars Science Laboratory, have the technology to measure organic compounds and mineralogy.

Outcome 3C.4: Progress in exploring the space environment to discover potential hazards to humans and to search for resources that would enable human presence.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA catalogues and researches NEOs to track objects that could pose an impact hazard to Earth, to study these building blocks of the solar system's formation, and to discover their potential as raw materials for future space exploration. In FY 2006, asteroid search teams funded by NASA's Near Earth Object Program discovered 37 near-Earth asteroids larger than one kilometer. Scientists also found 642 smaller objects bringing the total number of known near-Earth objects (NEOs) to 4,201 for all sizes. NASA's Jet Propulsion Laboratory, which computes the orbits of NEOs, determined that none appear to pose a threat to Earth in the next century; however, the Jet Propulsion Laboratory is monitoring 802 NEOs, of which 134 are larger than one kilometer in diameter, that are in orbits that could become a hazard in the more distant future.

In 2006, NASA commissioned a study by external experts to estimate the total number of NEOs based on the distribution of objects found to date. The study team estimated the population of NEOs larger than one kilometer is indeed about 1,100 (plus or minus 75). However, the team found that mean reflectivity (the amount of light reflected off the surface of the asteroid as measured from ground-based telescopes) for these objects is 20-percent brighter than previously thought. This implies that previously discovered NEOs are all slightly smaller than originally estimated. As a result, scientists have adjusted the number of identified NEOs larger than one kilometer to 689—or 63 percent of the estimated 1,100 large NEOs.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SSE5 Green	Successfully demonstrate progress in determining the inventory and dynamics of bodies that may pose an impact hazard to Earth. Progress toward achieving outcomes will be validated by external expert review.	5SSE5 Green	4SSE10 Green	None
6SSE6 Green	Successfully demonstrate progress in determining the physical characteristics of comets and asteroids relevant to any threat they may pose to Earth. Progress toward achieving outcomes will be validated by external expert review.	5SSE6 Blue	4SSE11 Green	3S8 Green
6SSE21 Green	Successfully demonstrate progress in identifying and understanding the hazards that the Martian environment will present to human explorers. Progress toward achieving outcomes will be validated by external expert review.	5MEP13 Green	4MEP15 Blue	3S8 Green
6SSE22 Green	Successfully demonstrate progress in inventorying and characterizing Martian resources of potential benefit to human exploration on Mars. Progress toward achieving outcomes will be validated by external expert review.	5MEP14 Yellow	4MEP16 Blue	3S8 Green
6SSE23 Green	Complete successful Martian orbit insertion for Mars Reconnaissance Orbiter (MRO).	5MEP2 Green	None	None

Sub-goal 3D *Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.*

NASA uses space- and ground-based telescopes, computer models, and theoretical studies to explore and understand phenomena like black holes, extra-solar planets, stars and galaxies. This research may reveal answers to some of humankind's eternal questions: How did the universe begin? Will the universe have an end? Are humans alone in the universe?

In FY 2006, NASA missions explored how the universe began, probed the nature of gravity, searched for planets beyond the Sun's solar system, and observed the effects of event horizons around black holes, the theoretical "point of no return" where nothing, not even light, can escape the black hole's immense gravitational pull. The Agency also made progress in the quest to identify Earth-like extra-solar planets. Recent observations indicate that some types of stars have flattened debris disks and possibly planets orbiting them, increasing the likelihood of discovering an Earth-like planet in the future.

Risks to Achieving Strategic Sub-goal 3D

NASA's operating missions that are exploring the universe and searching for Earth-like planets are going well; however, schedule delays, cost growth, and technical difficulties have delayed development and deployment of some instruments and projects. NASA's next generation of observatories and planet-finder missions are more complex and challenging than any mission to date. Any delays in these projects, or in the Kepler planet-finding mission, will impact the Agency's ability to achieve the Outcomes under Sub-goal 3D.

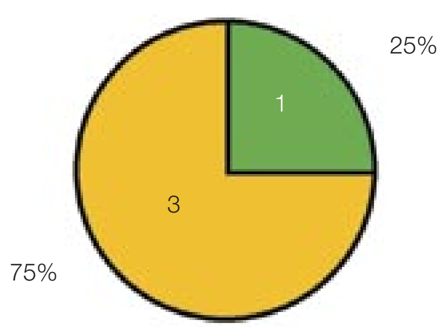
Resources, Facilities, and Major Assets

The biggest assets serving Sub-goal 3D are NASA's armada of operational spacecraft, including the three space telescopes comprising the Great Observatories: the Spitzer Space Telescope, the Hubble Space Telescope, and the Chandra X-ray Observatory. NASA also is developing next-generation astrophysics missions, including JWST, the Space Interferometer Mission (SIM), the Gamma-ray Large Space Telescope (GLAST), the Kepler mission, and the Wide Field Infrared Survey Explorer (WISE).

NASA also supports the Keck Interferometer, a ground-based telescope located atop the dormant volcano Mauna Kea in Hawaii. The Keck Interferometer combines the light from the twin Keck 10 meter diameter telescopes to search for planets in other solar systems.

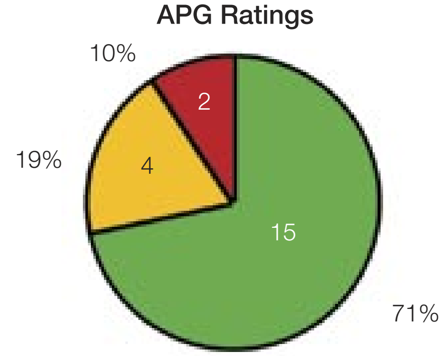
The cost of performance for Sub-goal 3D in FY 2006 was $1,910.95 million.

Outcome Ratings



Under Sub-goal 3D, NASA is on track to achieve 1 of 4 Outcomes.

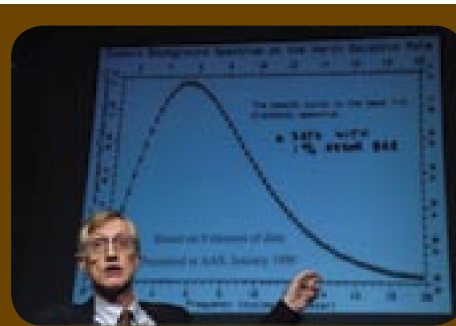
APG Ratings



Under Sub-goal 3D, NASA achieved 15 of 21 APGs.

NASA Scientist Shares Nobel Prize in Physics

John Mather, scientist at the Goddard Space Flight Center, and George Smoot, professor at the University of California, won the 2006 Nobel Prize in Physics for their collaborative work on understanding the Big Bang using data from NASA's Cosmic Background Explorer (COBE). COBE searched for cosmic microwave background radiation (leftover energy from the Big Bang) and paved the way for current microwave mapping techniques. The data provides evidence supporting the Big Bang theory by discovering variations in radiation and temperatures associated with the beginning of the universe.



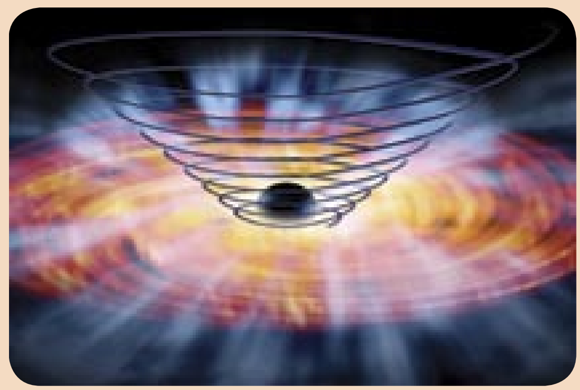
Left: John Mather shows some of the earliest data from the NASA Cosmic Background Explorer (COBE) spacecraft during a press conference held at NASA Headquarters. (NASA)

Outcome 3D.1: Progress in understanding the origin and destiny of the universe, phenomena near black holes, and the nature of gravity.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

In FY 2006, NASA scientists analyzed more than 100 supernovae, many discovered by the Hubble Space Telescope. Supernovae surveys enable NASA to identify a common type of stellar explosion that provides a spatial reference throughout the galaxy. They also provide a basis for studying the origins of dark energy, a mysterious force that appears to make up about 74 percent of the universe and may be responsible for the present-day acceleration of the expansion of the universe.

NASA's Wilkinson Microwave Anisotropy Probe (WMAP) has been instrumental in increasing scientists' understanding of the universe and its origin. In FY 2006, NASA used the data from WMAP to build the most detailed temperature map of the universe ever and the first full-sky map showing the "polarization" direction of the oldest light in the universe. The WMAP data will help researchers pinpoint when the first stars formed and give scientists new insight into the events that transpired in the first trillionth of a second of the universe.



During FY 2006, data from the Chandra X-ray Observatory showed for the first time how powerful magnetic fields are critical to the radiation emitted by black holes. The black hole's rotation twists magnetic fields, shown here as black lines in this simplified image. These fields accelerate the charged gas falling into the black hole, generating radiation that is seen as bright flashes by Chandra. (NASA/CXC/M.Weiss)

At the start of this fiscal year, NASA completed the Gravity Probe–B mission designed to test Einstein's theory of general relativity. While the nearly year-long mission is over, NASA scientists have just started analyzing the data.

In FY 2006, scientists at the Massachusetts Institute of Technology and Harvard University used data from NASA's Rossi X-ray Timing Explorer (RXTE) satellite to confirm the presence of theoretical borders around black holes called event horizons. RXTE also was instrumental in identifying a medium-sized black hole in the M82 galaxy cluster. This data is the first confirmation of the existence of a medium-sized black hole—one that is larger than the common stellar mass black holes and smaller than the super massive black holes that reside at the core of most galaxies.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6UNIV8 Green	Successfully demonstrate progress in searching for gravitational waves from the earliest moments of the Big Bang. Progress toward achieving outcomes will be validated by external expert review.	5SEU4 Green	4SEU9 Green	None

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6UNIV9 Green	Successfully demonstrate progress in determining the size, shape, and matter–energy content of the universe. Progress toward achieving outcomes will be validated by external expert review.	5SEU5 Blue	4SEU10 Green	3S1 Blue
6UNIV10 Green	Successfully demonstrate progress in measuring the cosmic evolution of dark energy. Progress toward achieving outcomes will be validated by external expert review.	5SEU6 Green	4SEU11 Blue	None
6UNIV11 Green	Successfully demonstrate progress in determining how black holes are formed, where they are, and how they evolve. Progress toward achieving outcomes will be validated by external expert review.	5SEU7 Green	4SEU12 Green	None
6UNIV12 Green	Successfully demonstrate progress in testing Einstein's theory of gravity and mapping space–time near event horizons of black holes. Progress toward achieving outcomes will be validated by external expert review.	5SEU8 Yellow	4SEU13 Green	3S2 Green
6UNIV13 Green	Successfully demonstrate progress in observing stars and other material plunging into black holes. Progress toward achieving outcomes will be validated by external expert review.	5SEU9 Blue	4SEU14 Green	None
6UNIV15 Green	Successfully demonstrate progress in exploring the behavior of matter in extreme astrophysical environments, including disks, cosmic jets, and the sources of gamma-ray bursts and cosmic rays. Progress toward achieving outcomes will be validated by external expert review.	5SEU11 Blue	4SEU16 Green	3S2 Green
6UNIV19 Yellow	Complete Gamma-ray Large Area Space Telescope (GLAST) spacecraft Integration and Test (I&T).	5SEU1 Yellow	None	None
6UNIV20 Red	Complete James Webb Space Telescope (JWST) mission Preliminary Design Review (PDR).	None	None	None

Performance Shortfalls

6UNIV19: NASA postponed the GLAST I&T and rescheduled the launch for early FY 2007.

6UNIV20: NASA revised the JWST schedule in response to growth in the cost estimate that NASA had identified in FY 2005. The Agency moved the launch date to 2013 and the PDR to March 2008.

Outcome 3D.2: Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.

FY 2006	FY 2005	FY 2004	FY 2003
Yellow	None	None	None

This year, scientists using NASA's Spitzer Space Telescope detected light that may be emanating from the earliest stars formed in the universe. Current theory suggests that space, time, and matter began with a "Big Bang" 13.7 billion years ago. Two hundred million years after that, the first stars formed. Scientists pointed Spitzer's infrared array camera at the Draco constellation to capture a diffuse glow of infrared light, invisible to the naked eye. The research team at the Goddard Space Flight Center believes that the glow is coming from a hypothesized class of stars believed to be the first stars formed in the universe, or perhaps from hot gas falling into the first black holes.

Two of NASA's Great Observatories, the Spitzer and the Hubble Space Telescope, provided data that is enabling scientists to "weigh" the stars in several distant galaxies. One of these galaxies, among the most distant ever seen, appears to be unusually massive and mature for its place in the young universe. This came as a surprise to astronomers since the earliest galaxies in the universe are commonly thought to have been much smaller groups of stars that gradually merged to build large galaxies like the Milky Way.

A team of astronomers also used Spitzer to discover and catalog nearly 300 clusters of galaxies. Almost one third of the clusters are as far as 10 billion light-years away, dating back to when the universe was very young. Galaxy clusters, especially young clusters, provide researchers with insight into how the first stars and massive galaxies formed.

Galactic collisions are a driving force behind star formation and the redistribution of stellar material throughout the universe. Spitzer recently observed an ongoing collision between the galaxy M82 and its neighbor M81. This collision produced a plume of hot dust stretching 20,000 light years from M82 into intergalactic space. If enough dust is released, a new galaxy or stellar cluster could form from this cosmic crash.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6UNIV14 Green	Successfully demonstrate progress in determining how, where, and when the chemical elements were made, and in tracing the flows of energy and magnetic fields that exchange them between stars, dust, and gas. Progress toward achieving outcomes will be validated by external expert review.	5SEU10 Green	4SEU15 Green	None
6UNIV16 Yellow	Successfully demonstrate progress in discovering how the interplay of baryons, dark matter, and gravity shapes galaxies and systems of galaxies. Progress toward achieving outcomes will be validated by external expert review.	5SEU12 Green	4SEU17 Green	3S1 Blue
6UNIV17 Green	Successfully demonstrate progress in learning how the cosmic web of matter organized into the first stars and galaxies and how these evolved into the stars and galaxies we see today. Progress toward achieving outcomes will be validated by external expert review.	5ASO5 Green	4ASO9 Blue	3S3 Green
6UNIV20 Red	Complete James Webb Space Telescope (JWST) mission Preliminary Design Review (PDR).	None	None	None

Performance Shortfalls

Outcome 3D.2: NASA made scientific progress toward the Outcome, but delays in the development and launch of JWST will impact future results. NASA postponed the launch date to 2013.

6UNIV16: External reviewers determined that NASA made limited progress in discovering how the interplay of baryons, dark matter, and gravity shapes galaxies and systems of galaxies.

6UNIV20: See Outcome 3D.1, above.

3D.3: Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.

FY 2006	FY 2005	FY 2004	FY 2003
Yellow	None	None	None

Recent discoveries revealed that the physical processes governing planet formation could occur under harsher conditions than originally thought. In FY 2006, researchers using NASA telescopes spotted planets, or planet-forming materials, around some unlikely places like brown dwarfs, which do not have sufficient mass to become true stars. Even dead stars may have a second chance at planet formation. Data from the Spitzer Space Telescope showed a planetary ring around a pulsar in the Cassiopeia constellation. In the star explosion that formed the pulsar, the original planets would have been destroyed; however, clumping in this disk could produce a new, albeit

In February 2006, NASA announced that the Spitzer Space Telescope identified two huge "hypergiant" stars circled by monstrous disks of what might be planet-forming dust (shown in this illustration compared to the Sun's solar system). Before this finding, scientists believed that such large stars were inhospitable to planets. The Spitzer finding expands the range of stars that can support dusty disks to include hypergiants. (NASA/JPL–Caltech/R. Hurt) stark, set of planets. These discoveries indicate that the process of star collapse can produce planet-forming disks.

NASA observations of the dusty material orbiting stars have revealed an abundance of carbon. Astronomers using data from NASA's Far Ultraviolet Spectroscopic Explorer (FUSE) observed large amounts of carbon gas in a dusty disk surrounding a young star named Beta Pictoris. Scientists are unsure if this system will give birth to worlds that are rich in graphite and methane or if the carbon is a common characteristic of young solar systems. NASA's Spitzer Space Telescope also observed carbon gas around a star in the Ophiuchus system, IRS 46. In contrast to the FUSE data, the data from Spitzer's infrared spectrometer identified carbon and nitrogen in the form of complex organic chains. These same building blocks are present in the Sun's solar system and were likely necessary for the development of life on Earth.

Delays in the SOFIA and JWST Programs will slow progress toward this Outcome because the Agency needs these two new observatories to continue studying star formation. In March 2006, NASA reviewed the status of SOFIA to identify and analyze options and decided to continue the SOFIA Program pending a restructuring, including joint management of the SOFIA airborne system (aircraft and telescope) development and flight-testing by NASA's Dryden Flight Research Center and the German Space Agency. The Agency plans to ferry the SOFIA airborne system to Dryden in early 2007 to initiate the extensive flight tests. NASA currently estimates that the flight test will conclude in 2010, after which the Agency will conduct an operational readiness review before beginning full science observation missions.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6UNIV1 Green	Successfully demonstrate progress in understanding how different galactic ecosystems of stars and gas formed and which ones might support the existence of planets and life. Progress toward achieving outcomes will be validated by external expert review.	5ASO6 Green	4ASO10 Green	None
6UNIV2 Green	Successfully demonstrate progress in learning how gas and dust become stars and planets. Progress toward achieving outcomes will be validated by external expert review.	5ASO7 Green	4ASO11 Green	3S3 Green
6UNIV6 Green	Successfully demonstrate progress in tracing the chemical pathways by which simple molecules and dust evolve into the organic molecules important for life. Progress toward achieving outcomes will be validated by external expert review.	5ASO11 Green	4ASO15 Green	2S6 Green
6UNIV18 Red	Complete Stratospheric Observatory for Infrared Astronomy (SOFIA) Airworthiness Flight Testing.	5ASO1 Red	None	None
6UNIV20 Red	Complete James Webb Space Telescope (JWST) mission Preliminary Design Review (PDR).	None	None	None

Performance Shortfalls

Outcome 3D.3: NASA made scientific progress on this Outcome, but future results will be impacted by delays in the development and deployment of the next generation of flight instruments.

6UNIV18: NASA delayed the SOFIA Airworthiness Flight Test.

6UNIV20: See Outcome 3D.1, above.

Outcome 3D.4: Progress in creating a census of extra-solar planets and measuring their properties.

FY 2006	FY 2005	FY 2004	FY 2003
Yellow	None	None	None

FY 2006 proved eventful for NASA's extra-solar planet hunt. Using NASA's space observatories and ground-based telescopes, an international team of astronomers found the smallest planet ever detected around a normal star outside this solar system. The extra-solar planet is five times as massive as Earth and orbits a red dwarf, a relatively

When Black Holes Collide

Einstein's theory of general relativity predicts that a collision between supermassive black holes will not radiate light like a supernova. Instead, it will emit gravity waves. These waves cause space-time to jiggle like a bowl of Jell-O (as shown in the illustration, right) and, because they rarely interact with matter, can penetrate the dust and gas that normally block scientists' view of black holes and other objects.

Scientists at the Goddard Space Flight Center have made a gigantic step towards detecting these waves. The NASA Ames Research Center tested a three-dimensional model, which simulates gravity waves during a collision between black holes of the same mass, using NASA's Columbia supercomputer and some of the most complicated astrophysical calculations ever performed. Scientists will be able to compare these results with data collected by the National Science Foundation's ground-based Laser Interferometer Gravitational-Wave Observatory (LIGO) and the proposed Laser Interferometer Space Antenna (LISA), a joint NASA–European Space Agency project, in order to confirm Einstein's theory.

(Henze, NASA)

cool star, every 10 years. The distance between the planet, designated OGLE-2005-BLG-390Lb, and its host is about three times greater than the distance between Earth and the Sun. The planet's large orbit and its dim parent star make its likely surface temperature a frigid minus 364 degrees Fahrenheit (minus 220 degrees Celsius).

Researchers using the Spitzer Space Telescope detected a "hot Jupiter," a large gas giant planet that reflects considerable infrared radiation. The planet orbits relatively close to its star (closer than Earth's orbit around the Sun) and has a scorching temperature of 1,551 degrees Fahrenheit—hot enough to stand out despite the close presence of its parent star.

In February 2006, an international team of amateur and professional astronomers, using off-the-shelf equipment provided by NASA, confirmed that they had discovered a Jupiter-sized planet circling a Sun-like star 600 light-years from Earth. NASA brought amateur astronomers into the Agency's extra-solar planet hunt back in 2002 as a way to expand the search team while engaging the public.

Funding pressures within the Agency's Astrophysics Division and delays with the Kepler mission will impact future planet-finding missions. Kepler, a NASA Discovery mission designed to look at a wide field of stars for transitioning planets, has contractor and workforce issues with regard to the primary instrument. The launch readiness date for Kepler slipped from June 2008 to November 2008, resulting in a subsequent delay for supported missions.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6UNIV3 Green	Successfully demonstrate progress in observing planetary systems around other stars and comparing their architectures and evolution with our own. Progress toward achieving outcomes will be validated by external expert review.	5ASO8 Green	4ASO12 Blue	3S4 Blue
6UNIV4 Green	Successfully demonstrate progress in characterizing the giant planets orbiting other stars. Progress toward achieving outcomes will be validated by external expert review.	5ASO9 Blue	4ASO13 Green	3S4 Blue
6UNIV5 Yellow	Successfully demonstrate progress in determining how common Earth-like planets are and whether any might be habitable. Progress toward achieving outcomes will be validated by external expert review.	5ASO10 Blue	4ASO14 Green	None
6UNIV7 Green	Successfully demonstrate progress in developing the tools and techniques to search for life on planets beyond our solar system. Progress toward achieving outcomes will be validated by external expert review.	5ASO12 Green	4ASO16 Blue	3S4 Blue 3S6 Green
6UNIV21 Yellow	Begin Kepler spacecraft Integration and Test (I&T).	5ASO2 Green	None	None

Performance Shortfalls

Outcome 3D.4: NASA made scientific progress on this Outcome, but future results will be impacted by delays in the development and deployment of the next generation of flight instruments.

6UNIV5: Continued delays of SIM and Kepler constitute slow progress toward achieving this APG.

6UNIV21: NASA delayed the Kepler spacecraft I&T.

Sub-goal 3E *Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.*

NASA is the Nation's leading government organization for aeronautical research. This world-class capability is built on a tradition of expertise in core disciplines like aerodynamics, acoustics, combustion, materials and structures, and dynamics and control. NASA's Aeronautics Research Mission Directorate conducts research that will enhance significantly aircraft performance, environmental compatibility, and safety, and that will also enhance the capacity, flexibility, and safety of the future air transportation system.

In FY 2006, NASA substantially restructured the Aeronautics Research Mission Directorate to focus on cutting-edge fundamental research and revolutionary capabilities that will benefit NASA, other government agencies, the broad aeronautics community, and the Nation. As part of this restructuring, NASA created the following four new programs:

- The Fundamental Aeronautics Program develops system-level, multi-disciplinary capabilities in critical core areas of aeronautics technology for both civilian and military applications;
- The Aviation Safety Program develops principles, guidelines, concepts, tools, methods, and technologies to improve aviation safety;
- The Airspace Systems Program develops technologies, concepts, and capabilities for operational management of the National Airspace System and the aircraft that fly within it; and
- The Aeronautics Test Program stewards the Agency's key aeronautics test facilities, some of which are considered national assets.

Risks to Achieving Sub-goal 3E

NASA identifies highly challenging, cutting-edge aeronautics research goals which, by their nature, are inherently high risk. Even if each milestone is not met fully, the information NASA gains advances knowledge of aeronautics and helps the Agency make informed decisions to realign research to the appropriate areas. Redirection of resources to meet other national priorities is another major risk to NASA's programs and schedules. Should this occur, the Aeronautics Research Mission Directorate will re-align program milestones and schedules as needed to respond to such changes.

The Fundamental Aeronautics, Aviation Safety, and Airspace Systems Programs partner with other government agencies, industry, and universities to meet program objectives. These partnerships provide many benefits, but also introduce external dependencies that could influence schedules and research output. The programs will mitigate this risk through close coordination with these partners.

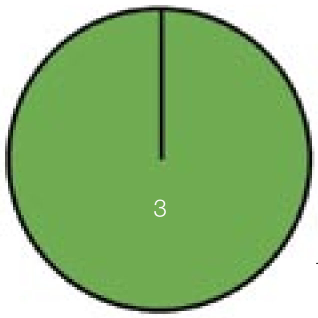
Resources, Major Facilities, and Assets

NASA maintains several national aeronautics research assets, including wind tunnels at the Ames, Glenn, and Langley Research Centers. Facilities like the Icing Research Tunnel, the 8-foot High Temperature Tunnel, and the Thermal/Acoustic Facility allow NASA and Agency partners to test aircraft under various conditions.

In addition to ground-based test and research facilities, NASA maintains a number of research aircraft, including F-15 and F-18 jets used to test new systems, icing research aircraft like the twin-engine turboprop Twin Otter, subsonic research aircraft like the twin turbo-fan Gulfstream III, and the C-17 transport aircraft. NASA houses most of these aircraft at the Dryden Flight Research Center, the Agency's flight research and test hub.

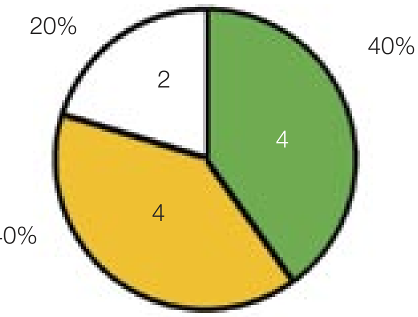
The estimated cost of performance for Sub-goal 3E was $1,050.00 million.

Outcome Ratings



Under Sub-goal 3E, NASA is on track to achieve all 3 Outcomes.

APG Ratings



Under Sub-goal 3E, NASA achieved 4 of 10 APGs.

Outcome 3E.1: By 2016, identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the Next Generation Air Transportation System (projected for the year 2025).

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

A dynamically scaled Generic Transport Model, part of the AirSTAR testbed, is shown coming in for a landing. NASA will use it for flight validation of high-risk upset flight maneuver and damage conditions, along with validation of resilient control algorithms and advanced adaptive control systems. (NASA)

During FY 2006, the Aeronautics Research Mission Directorate realigned the Aviation Safety Program into four project areas that focus on the foundational technologies needed to address safety issues of current and future air vehicles that will be operating in the Next Generation Air Transportation System:

- The Aircraft Aging and Durability project supports research to predict, detect, and/or mitigate damage or degradation of aircraft materials and structures due to aging related hazards;
- The Integrated Intelligent Flight Deck project develops flight deck technologies that mitigate operator-, automation-, and environment-induced hazards for future operational concepts;
- The Integrated Vehicle Health Management project develops technologies to detect and correct system/component degradation and malfunctions early enough to prevent or recover from an in-flight failure that could lead to an accident; and
- The Integrated Resilient Aircraft Control project develops capabilities to reduce (or eliminate) aircraft loss-of-control accidents and ensure safe flight under off-nominal conditions.

During FY 2006, the Aviation Safety Program conducted computer modeling of crack growth in aging aircraft to develop failure mitigation techniques and to help engineers design more damage-tolerant materials. In addition, the program made improvements to the NASA Icing Research Tunnel facility to enable research on super-cooled liquid droplets. In April 2006, the program completed a live demonstration of new data mining tools. The data mining tools will be used to query information from a distributed archive of flight operational data held by participating operators. The goal of this activity is to use operational flight data to detect technical flaws or unsafe conditions early enough to avert accidents. The program also completed the Airborne Subscale Transport Aircraft Research (AirSTAR) testbed and began demonstrating operational readiness in September. NASA will use the AirSTAR test bed to flight test technologies that will require unusual attitude conditions that cannot be safely achieved by a full-scale civil transport category aircraft.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6AT4 Green	In partnership with the FAA, the Commercial Aviation Safety Team (CAST), and the aviation community, provide an initial demonstration of a voluntary aviation safety information sharing process.	None	None	None
6AT14 Yellow	Complete Aviation Safety Program restructuring activities in order to focus research efforts more precisely on the Nation's aviation safety challenges for the Next Generation Air Transportation System (2025) and beyond.	None	None	None
6AT15 Yellow	Utilizing a competitive peer-reviewed selection process, determine the research portfolio and partnerships to enable advances in the Aviation Safety thrust areas (Integrated Intelligent Flight Deck Technologies, Integrated Vehicle Health Management, Integrated Resilient Aircraft Controls, and Aircraft Aging and Durability).	None	None	None

Performance Shortfalls

6AT14 and 6AT15: The Aviation Safety Program delayed approval of one of its four projects: the Integrated Resilient Aircraft Control, which develops capabilities to reduce (or eliminate) aircraft loss-of-control accidents and ensure safe flight under off-nominal conditions. Program management expects final approval of this project during the first quarter of FY 2007.

Outcome 3E.2: By 2016, develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the Next Generation Air Transportation System.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA successfully completed the Small Aircraft Transportation System (SATS) project in FY 2006. The project focused on improving four operating capabilities: higher-volume operations at airports without traffic-control towers or radar; lower landing minimums at minimally equipped airfields; increased single pilot performance; and en-route procedures for integrated fleet operations. SATS conducted final assessments and evaluations, and published the project's successes in the Air Traffic Control Association's Journal of Air Traffic Control.

Thousands of aircraft cross the United States in this FACET snapshot of air traffic taken on July 10, 2006, at 2:45 p.m. EST. Originally developed by the Ames Research Center as a research tool to explore traffic management concepts, FACET has transitioned to a commercially licensed traffic management tool. NASA continues to use the tool in the Agency's aeronautics research. (NASA)

The Virtual Airspace Modeling and Simulation (VAMS) project successfully developed its system-wide operational concept, which provides a detailed description of a future capacity-enhancing concept for the National Airspace System and an assessment of its potential capacity benefits. The assessment was performed using the VAMS-developed Airspace Concepts Evaluation System (ACES) assessment tool that models gate-to-gate operations of the National Airspace System. Using ACES, VAMS demonstrated that the system-wide concept could accommodate the targeted doubling of capacity (relative to 1997 throughput).

The Future Air Traffic Management Concepts Evaluation (FACET) Tool won NASA's Software of the Year Award for 2006. FACET is a flexible software tool that models the National Airspace System. Its powerful simulation capabilities can rapidly generate thousands of aircraft trajectories to enable efficient planning of traffic flows at the national level.

NASA restructured the Airspace Systems Program to align research efforts with the Joint Planning and Development Office's Next Generation Air Transportation System (NGATS) goals for 2025. (The Joint Planning and Development Office is a collaboration among government agencies, industry, and the public sector to plan and enable NGATS.) NASA identified major research thrust areas: the NGATS Air Traffic Management Airspace project and the NGATS Air Traffic Management Airportal project. The program focuses on finding technological solutions for automated air traffic management as a step toward creating a safe, efficient, high-capacity, and integrated NGATS.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6AT7 Green	Successfully complete the SATS integrated technology demonstration and final assessment.	None	None	None
6AT16 Yellow	Complete Airspace Systems Program restructuring activities in order to align research efforts to address the Joint Planning and Development Office's Next Generation Air Transportation System (NGATS) capability requirements for 2025.	None	None	None
6AT17 Yellow	Utilizing a competitive peer-reviewed selection process, determine the research portfolio and partnerships to enable advances in the Airspace Systems thrust areas (Next Generation Air Transportation Systems and Super Density Surface Management).	None	None	None

Performance Shortfalls

6AT16 and 6AT17: The Airspace Systems Program delayed approval of a portion of its project portfolio (the NGATS Air Traffic Management Airportal project) that will develop capabilities to increase throughput in terminal and airport domains enabling NGATS. Program management expects final approval of this project, including its peer-reviewed research portfolio and partnerships, during the first quarter of FY 2007.

Outcome 3E.3: By 2016, develop multidisciplinary design, analysis, and optimization capabilities for use in trade studies of new technologies, enabling better quantification of vehicle performance in all flight regimes and within a variety of transportation system architectures.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

The Fundamental Aeronautics Program is focusing on long-term investments in cutting-edge fundamental research in traditional aeronautics disciplines. The key objectives guiding this new focus are to re-establish NASA's commitment to mastering the fundamental technology of subsonic (rotary and fixed wing), supersonic, and hypersonic flight, and to focus NASA's unique research capabilities in areas that have the potential to expand the capabilities of future aircraft for the greatest national benefit (e.g., higher performance, lower noise, and reduced emissions). All four projects within the program had significant accomplishments, including those listed below.

The Rotary Wing project conducted a helicopter flight test to provide data for rotorcraft acoustic analysis validation and to develop low-noise flight profiles. NASA conducted the test with project partners: the U.S. Army, the Center for Rotorcraft Innovation, Bell Helicopter, and the University of Maryland. The project team will use the results of these tests to validate advanced prediction models that can be used for future design exercises.

NASA's Fixed Wing project, in collaboration with Pratt & Whitney, completed the design of geared turbofan components. Based on studies, the project partners selected a design—a low fan-pressure-ratio geared turbofan with a lightweight Variable Area Fan Nozzle—that reduces both noise and emissions relative to current engines.

The Supersonics project completed an initial study of the impact of atmospheric turbulence on very-low-noise sonic boom waveforms. NASA used F-18 aircraft, flying a specially designed flight profile, to generate the booms, which occur when aircraft fly faster than the speed of sound. NASA recorded indoor and outdoor waveform shapes, noise levels, and building vibration data for use in model validation studies. This research will help project engineers develop ways to reduce the sonic-boom noise produced by supersonic aircraft.

The Hypersonics project completed the Mach 5 testing of the Ground Demonstration Engine–2 in the NASA 8-Foot High Temperature Tunnel. NASA teamed with the Air Force Research Laboratory and Pratt & Whitney Rocketdyne to complete the tests. The NASA tests marked the first time a closed-loop, hydrocarbon-fueled, fuel-cooled scramjet was tested at hypersonic conditions. Fuel cooling of the scramjet is essential for the hardware to survive the temperatures found in hypersonics flight.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6AT8 White	Identify and document engine configuration and noise reduction technologies needed to enable 10 dB reduction in aircraft system noise. (APG revised based on FY06 Appropriation.)	5AT4 Green	None	None
6AT11 White	Complete trade study of unconventional propulsion concepts for a zero-emissions vehicle.	None	None	None
6AT18 Green	Complete Fundamental Aeronautics Program restructuring activities in order to focus efforts on fundamental research to develop physics-based multidisciplinary design, analysis, and optimization tools.	None	None	None
6AT19 Green	Utilizing a competitive peer-reviewed selection process, determine the research portfolio and partnerships to enable advances in the Fundamental Aeronautics thrust areas (fixed wing, rotary wing, supersonics, and hypersonics).	None	None	None

Performance Shortfalls

6AT8 and 6AT11: NASA canceled these APGs because they no longer aligned with the Agency's aeronautics research goals.

Sub-goal 3F *Understand the effects of the space environment on human performance, and test new technologies and countermeasures for long-duration human space exploration.*

Human exploration is the cornerstone of the Vision for Space Exploration. The space environment holds many challenges for the human body, including exposure to radiation, atrophy of unused muscles, and calcium loss in weight-bearing bones that reduces bone density and increases fracture risks. NASA is researching and developing the countermeasures necessary to assure the health of today's astronauts and the next generation of human explorers.

NASA is preparing not only for extraordinary hazards associated with space travel, but also for the everyday problems that human explorers may face on extended duration missions. Researchers are looking at seemingly simple issues like crew comfort, food preparation, and life-support while also preparing for potentially hazardous major events like spacecraft fires and solar flares. In FY 2006, NASA prepared for long-duration human space exploration missions by testing spacesuits for comfort and mobility, conducting bed rest studies, developing experiments for the International Space Station (ISS), and continuing other life support projects.

Assuring the health of human space explorers begins on the ground, so this Sub-goal also covers the Agency's medical certification program that confirms all astronauts are fit to fly and perform their duties.

NASA is developing Advanced Environmental Monitoring and Control systems for flight on the ISS (and ultimately Orion) to detect harmful contaminants in the atmosphere and alert the crew. In this photo, project scientist Jake Maule uses the Lab-on-a-Chip Application Development (LOCAD)–Portable Test System, a hand-held device for rapid detection of potentially harmful biological and chemical substances, aboard NASA's KC-135 microgravity research aircraft. (NASA)

Risks to Achieving Sub-goal 3F

NASA's research and development efforts for human exploration rely on national and international partnerships that enable NASA to expand the Agency's pool of research data and reduce redundant efforts. NASA has established relationships with the Agency's partners through both the International Space Life Sciences Working Group and ISS partnerships. NASA also relies on access to the Russian Institute of Biomedical Problems, the MEDES Institute for Space Medicine and Physiology bed rest and centrifuge facility in Toulouse, France, and the German Space Agency's bed rest and centrifuge facility in Cologne, Germany. NASA's Human Research Program (the program responsible for developing human spaceflight countermeasures) depends on maintaining good relations with the Department of Energy to assure availability of critical radiation research facilities at the Brookhaven NASA Space Research Laboratory. Like any cooperative effort, these partnerships create the potential for delays, which could affect the development of exploration technologies.

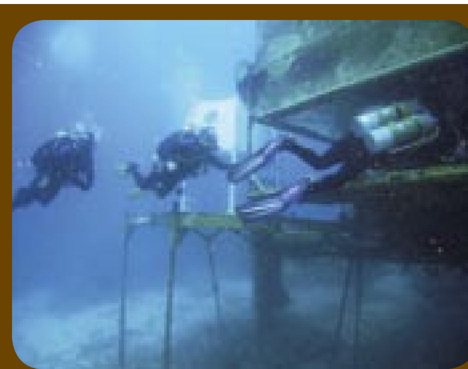
Additional internal risks include cross-program management between the Agency's Human Research Program and related work in Constellation Systems. Changes in the ISS/Shuttle manifest schedule also could impact progress toward this Sub-goal.

Resources, Facilities, and Major Assets

NASA uses numerous ground-based research facilities to support human exploration efforts like the 2.2- and 5-second Drop Towers at the Glenn Research Center, which support short-term microgravity studies without an ISS mission or parabolic flights. These facilities enable space-related research at reduced risk and cost in comparison with flight missions; however, they cannot substitute for the necessary experience of living and working in space.

NASA Tests Space Capabilities at Undersea Lab

The NASA Extreme Environment Mission Operations (NEEMO) uses an undersea laboratory to test technologies and capabilities for future human space exploration. During FY 2006, NASA conducted three NEEMO missions at the Aquarius Underwater Laboratory, located off the coast of Key Largo, Florida. The laboratory's remote location and extreme environment makes it a good analog for space exploration. During the missions, the crew conducted "moon walks" to collect "lunar" samples and constructed a Waterlab. They tested techniques for communication and navigation and used a remote-operated vehicle, affectionately named Scuttle by the crew, to determine its usefulness in various situations such as night exploration. In addition, the crew of NEEMO–9 assisted a doctor while he performed remote long-distance surgery on a simulated wound, testing technologies that could be used for future telemedicine on Earth or in space.

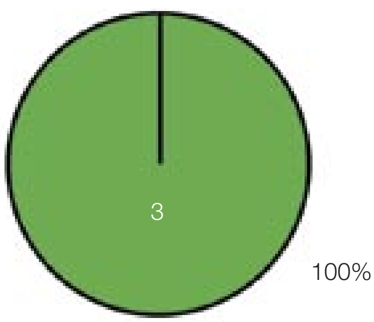


Crew members for the NEEMO–9 mission arrive at their underwater home on April 3, 2006. The crew stayed inside the Aquarius Underwater Laboratory for 15 days. (NASA)

NASA's largest facility—and asset—supporting the development of technologies for human exploration is the International Space Station. The ISS allows NASA and the Agency's international partners to develop and test countermeasures, life-support technologies, and exploration capabilities over many months in the space environment. The ISS is currently the best analog for future human missions to the Moon and Mars.

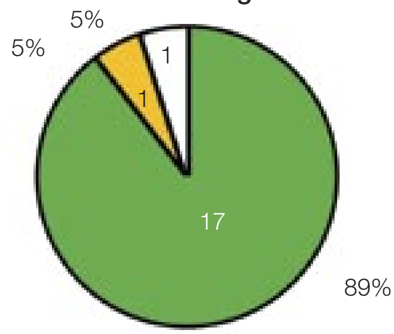
The cost of performance for Sub-goal 3F in FY 2006 was $367.07 million.

Outcome Ratings



Under Sub-goal 3F, NASA is on track to achieve all 3 Outcomes.

APG Ratings



Under Sub-goal 3F, NASA achieved 17 of 19 APGs.

Outcome 3F.1: By 2008, develop and test candidate countermeasures to ensure the health of humans traveling in space.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

With ever-increasing precision, NASA is developing countermeasures to assure the health of astronauts during long-duration missions. NASA is preparing for future exploration missions by conducting studies on bone loss, circulatory stress, drug interactions in space, behavioral health, microbial growth and virulence, and other areas. The Foot–Ground Reaction Forces experiment, concluded in April 2006, will help scientists understand the mechanics of bone mineral loss so they can create mechanical and pharmaceutical countermeasures. At the end of FY 2006, NASA had collected data from 18 subjects for the renal stone countermeasure experiment, and researchers expect to complete the experiment in March 2007. The data provided by this experiment will help NASA mitigate the occurrence of kidney stones while crewmembers are in space.

In addition to the deteriorating effects of microgravity, space poses several other challenges to astronauts, including the effects of space radiation on living organisms. In FY 2006, NASA scientists completed a study of high-energy, heavy particle radiation to identify the best ways to protect human crews. The results of the study will be published in FY 2007.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SFS5 Green	Achieve a 5 percent reduction in downtime.	None	None	None
6SFS6 Green	Certify medical fitness of all crewmembers before launch.	5SFS20 Green	4SFS10 Green	None
6HSRT9 Yellow	Complete renal stone countermeasure development.	None	None	None
6HSRT10 Green	Start testing of bone and cardiovascular countermeasures in space.	None	None	None
6HSRT11 Green	Deliver report from National Council on Radiation Protection and Measurements on lunar radiation protection requirements.	None	None	None
6HSRT20 Green	Complete the physics database for shielding in the region above 2 GeV per nucleon.	None	None	None

Performance Shortfalls

6HSRT9: Although researchers made progress toward achieving this APG, the renal stone experiment will not be complete until data is collected on one more subject. NASA expects to complete the study in FY 2007.

Outcome 3F.2: By 2010, identify and test technologies to reduce total mission resource requirements for life support systems.

FY 2006	FY 2005	FY 2004	FY 2003
Green	Green	None	None

Current life support systems for space travel are large, heavy, and require considerable amounts of power that significantly increase the costs and resources needed for crewed missions. NASA is pursuing technologies to reduce the weight and resource demands of these systems. In FY 2006, NASA continued testing the Vapor Phase Catalytic Ammonia Removal Unit. This system will help convert human liquid wastes into drinkable water. NASA is conducting final verification of the ISS Fluids Integrated Rack and the Constrained Vapor Bubble Heat Exchanger to prepare them for launch to the ISS. NASA also is working on technologies for increasing carbon dioxide removal efficiency and converting recycled air into oxygen and water.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6HSRT13 Green	Start validation testing of a spacecraft water purification system called the Vapor Phase Catalytic Ammonia Removal Unit.	None	None	None
6HSRT14 White	Define requirements for the Condensing Heat Exchanger Flight experiment focused on improving space condenser reliability.	None	None	None
6HSRT15 Green	Complete and deliver for launch the ISS Fluids Integrated Rack.	None	None	None
6HSRT16 Green	Complete and deliver for launch experiments to explore new lightweight heat rejection technologies.	None	None	None
6HSRT17 Green	Start technology testing and assessment of the Solid Waste Compaction processor.	None	None	None
6HSRT18 Green	Conduct next-generation lithium hydroxide (LiOH) packaging tests to improve carbon dioxide removal efficiency.	None	None	None

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6HSRT19 Green	Conduct ground testing of the Sabatier unit to demonstrate reliability in recovering oxygen and water from carbon dioxide.	None	None	None

Performance Shortfalls

6HSRT14: NASA canceled the Condensing Heat Exchanger Flight experiment.

Outcome 3F.3: By 2010, develop reliable spacecraft technologies for advanced environmental monitoring and control and fire safety.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

Fires, air quality, and environmental monitoring are significant challenges in the high oxygen environment and close quarters of a spacecraft. To mitigate these risks, NASA is developing technologies to monitor cabin air quality and water quality and to improve ways to detect and extinguish fires. Technologies under development in FY 2006 included the Vehicle Cabin Air Monitoring System, a hand-held water monitoring system, and advanced smoke detection tools using data from the Dust and Aerosol Measurement Feasibility Tests experiment flown on the ISS. In addition, the Droplet Flame Extinguishment Experiment and the ISS Combustion Integrated Rack are undergoing final verification for flight and installation on the ISS. This equipment will enable further combustion and fire suppression experiments in microgravity.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6HSRT3 Green	Demonstrate the ability of the advanced spacecraft air monitoring system to detect 90 percent of the high-priority air contaminants in ground testing.	None	None	None
6HSRT4 Green	Demonstrate the ability of the hand-held water monitoring system to detect spacecraft water biocides and high-priority metal contaminants in ground testing.	None	None	None
6HSRT5 Green	Support development of a new generation of reliable spacecraft smoke detectors by finishing measurements of ISS background particulates using the DAFT experiment and delivering for launch the Smoke and Aerosol Measurement Experiment (SAME).	None	None	None
6HSRT6 Green	Complete and deliver for launch the ISS Combustion Integrated Rack (CIR).	None	None	None
6HSRT7 Green	Complete and deliver for launch the Droplet Flame Extinguishment in Microgravity Experiment aimed at quantifying fire suppressant effectiveness.	None	None	None
6HSRT8 Green	Develop a revised space materials flammability characterization test method and update NASA-STD-6001 accordingly.	None	None	None

Strategic Goal 4 *Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.*

With the Space Shuttle's retirement scheduled for 2010, NASA must develop a next-generation space transportation system to deliver crew and cargo to the International Space Station (ISS). Unlike the Shuttle, the new Constellation System vehicles will travel beyond low Earth orbit to return humans to the Moon and eventually carry them to Mars and beyond.

The first vehicles in the Constellation System will be the Orion Crew Exploration Vehicle (CEV) and the Ares I Crew Launch Vehicle (CLV). The Orion CEV will use reliable elements from the Apollo and Shuttle systems, but it also will incorporate the latest in shielding, computer technologies, and support systems. The Ares I CLV also will leverage existing technologies and systems to provide an affordable, reliable, and safe method for launching humans and cargo into orbit. To launch the new vehicles beyond low Earth orbit, NASA is developing the Ares V heavy lift launcher. It will have capabilities similar to the Saturn V rocket used for the Apollo missions.

In this artist's concept, the Orion Crew Exploration Vehicle approaches the International Space Station. (NASA)

NASA's goal is to have the Orion CEV and Ares I CLV operational as close to 2010 as possible, but no later than 2014.

Risks to Achieving Strategic Goal 4

Potential risks to the successful completion of the Orion CEV/Ares I CLV space transportation system include workforce and asset transitioning and given that NASA has not developed a new lunar spacecraft in over 30 years, unexpected technical hurdles. In FY 2007, NASA will begin transitioning workforce and assets from the Space Shuttle Program to the Constellation Systems Program. To mitigate the risks associated with this major transition, the Agency will use a number of working groups and control boards, including the Transition Control Board, the Joint Integration Control Board, and the Headquarters Transition Working Group, to coordinate actions across programs.

Assessments

In FY 2006, the Office of Management and Budget (OMB) assessed the Constellation Systems Program with OMB's Program Assessment Rating Tool (PART). OMB assessed the overall program as "Adequate," with the following scores by program section:

Kennedy Space Center Prepares for Constellation Systems

The Kennedy Space Center will support NASA's new Constellation Systems by using existing assets that support the Space Shuttle Program. NASA initiated an effort to support construction, alteration, renovation, and repair of buildings and structures that will form the Constellation Systems processing and launch infrastructure. Early concepts include using assets like the Shuttle Crawler Transporter to meet Ares I/Orion vehicle ground support requirements. The Kennedy Space Center and the State of Florida entered into a Space Act Agreement to conduct studies on assembly and checkout facilities and the preparation of a high bay for these activities.

Right: An early concept drawing shows the CLV being transported to the Pad on the modified Shuttle Crawler Transporter following stacking operations in the Vehicle Assembly Building. (NASA)

- Program Purpose and Design—100%
- Strategic Planning—78%
- Program Management—75%
- Program Results/Accountability—40%

OMB cited a major deficiency in the Program Management area for the Constellation Systems Program related to Agency-wide problems with integrating NASA's new systems for financial and administrative management. The lower scores in the Program Results/Accountability and Strategic Planning areas were due to the relative newness of the program and the limited baselines for comparison and evaluation.

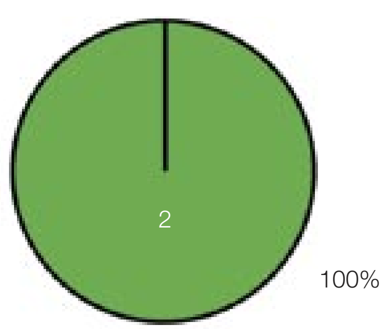
Resources, Facilities, and Major Assets

Some of the major facilities supporting Constellation Systems Program activities include the following:

- The Johnson Space Center is managing the CEV project. Johnson also manages astronaut training, so NASA is constructing training mock-ups of the CEV crew module and other elements in Johnson's Mock-up Facility.
- The Stennis Space Center will test the J–2X engine that will power the upper stage of Ares I and the Earth-departure stage of the Ares V cargo launch vehicle. During FY 2007, NASA will decommission the A-1 Test Stand that has been used to test Shuttle engines since 1975 and convert it for testing the J–2X engine. In the future, NASA will test the RS-68 rocket that will power the Ares V's main stage at Stennis's B-1 Test Stand.
- The Glenn Research Center will test the J–2X engine in its Cryogenic Propellant Tank Facility, which simulates the extreme cold and vacuum of space.
- The Langley Research Center will characterize the aerodynamics of the Orion CEV in the Center's wind tunnel facilities.
- The Michoud Assembly Facility, which currently builds external tanks for the Shuttle, will assemble the Ares upper stages.
- The Kennedy Space Center will manage launch operations. Over the next several years, NASA will transition Kennedy's Shuttle facilities and build new facilities to serve the future needs of the Constellation Systems Program.

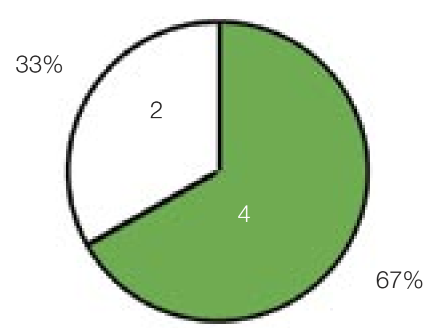
The cost of performance for Strategic Goal 4 in FY 2006 was $1,622.16 million.

Outcome Ratings



Under Strategic Goal 4, NASA is on track to achieve both Outcomes.

APG Ratings

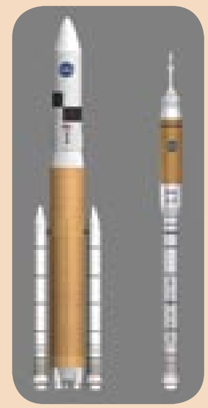


Under Strategic Goal 4, NASA achieved 4 of 6 APGs.

Outcome 4.1: No later than 2014, and as early as 2010, transport three crewmembers to the International Space Station and return them safely to Earth, demonstrating an operational capability to support human exploration missions.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA is making progress on the development of the Orion CEV and Ares I CLV. During FY 2006, NASA awarded contracts to Alliant Techsystems and Pratt & Whitney Rocketdyne for Ares I first stage and upper stage engine development, respectively. NASA engineers conducted over 80 wind tunnel tests on a partial model of the Ares I vehicle that included a portion of the upper stage, the spacecraft adapter, the Orion CEV, and the launch abort system. Data collected during these tests will help engineers modify the system's aerodynamics to maximize the vehicle's flight capabilities. The Agency also completed preliminary tests of an "augmented spark igniter" for Ares I. This vital component acts as the rocket's "spark plug," igniting the liquid hydrogen and liquid oxygen propellants needed to power the spacecraft.



This artist's concept drawing shows the Ares V heavy lift cargo launch vehicle (left) and the Ares I crew launch vehicle (right). (NASA)

On August 31, NASA named Lockheed Martin as the primary contractor to help the Agency design, develop, test, and certify the Orion CEV.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6CS1 Green	Conduct the Earth Orbit Capability (Spiral 1) Systems Requirements Review to define detailed interface requirements for the Crew Exploration Vehicle, the Crew Launch Vehicle, and supporting ground and in-space systems.	5TS1 Green	None	None
6CS2 Green	Competitively award contract(s) for Phase A and Phase B design and flight demonstration of the Crew Exploration Vehicle.	None	None	None
6CS3 Green	Develop detailed Crew Launch Vehicle design and operational modifications to support human rating and exploration mission architecture requirements.	5TS3 Green	None	None
6CS4 Green	Develop a plan for systems engineering and integration of the exploration System of Systems; clearly defining systems and organizational interfaces, management processes, and implementation plans.	None	None	None

Outcome 4.2: No later than 2014, and as early as 2010, develop and deploy a new space suit to support exploration, that will be used in the initial operating capability of the Crew Exploration Vehicle.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA is redefining the Extravehicular Activity Systems (i.e., spacesuits and other equipment) for the Constellation Systems Program due to evolving budget priorities. During FY 2006, the Constellation Systems Program re-evaluated the requirements driving spacesuit design and determined that instead of developing two spacesuits—one for use in space and one for use on the lunar surface—the Constellation Systems Program will develop a single, integrated spacesuit. The spacesuit design also will incorporate maximum design flexibility and modularity to allow for the efficient integration of upgrades. This approach should reduce the development costs of this project.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6HSRT1 White	Complete the technology trade studies for both the in-space and surface EVA suits.	None	None	None

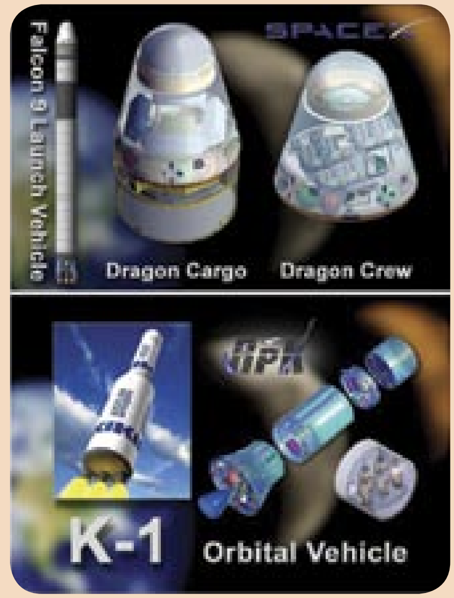
FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6HSRT2 White	Complete the system requirements review for both the in-space and surface exploration EVA suits.	None	None	None

Performance Shortfalls

6HSRT1 and 6HSRT2: Due to changes in the Extravehicular Activity Systems architecture, NASA management canceled these APGs. NASA will include appropriately revised APGs in the FY 2007 Performance Plan.

Strategic Goal 5 *Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.*

The landscape of the space industry is changing. The recent award of the Ansari X–Prize and other ongoing private space efforts has strengthened the potential for the commercial space sector to expand into new markets. NASA is collaborating with established commercial launch service providers while also encouraging development of the emerging entrepreneurial launch sector through incentives like Space Act Agreements and prize competitions. Through these partnerships, NASA will gain access to a wider selection of competitively priced technology, services, and capabilities.



In FY 2006, NASA signed Space Act Agreements with SpaceX and Rocketplane–Kistler to design vehicle options for delivering cargo to the International Space Station. This picture shows artist renditions of SpaceX's Dragon cargo and crew elements (top) and Rocketplane Kistler's orbital vehicle. (NASA)

Risks to Achieving Strategic Goal 5

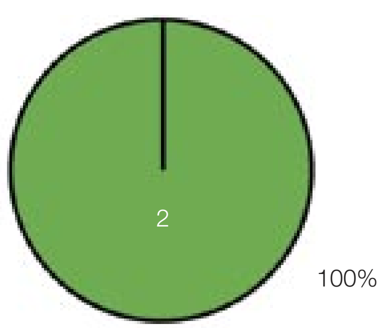
NASA payloads are often one-of-a-kind, complex, and expensive, so it is imperative that NASA take all reasonable measures to assure successful launches. The greatest challenges associated with Strategic Goal 5 are finding emerging companies that can demonstrate the required launch capabilities and mitigating additional risk associated with using less experienced commercial launch providers. NASA's Commercial Orbital Transportation Services (COTS) project reflects the Agency's goal of acquiring launch services from emerging launch providers to free up government resources for projects like the Orion Crew Exploration Vehicle.

Resources, Facilities, and Major Assets

NASA currently does not use any of the Agency's major facilities to support activities contributing to Strategic Goal 5. However, NASA does make available to the Agency's commercial partners many of the Agency's world-class facilities, like rocket propulsion test stands and wind tunnels, so they can test developmental technologies. The major assets supporting Strategic Goal 5 are NASA's workforce managing the Commercial Crew and Cargo Program Office at Johnson Space Center and the Agency's many industry partners.

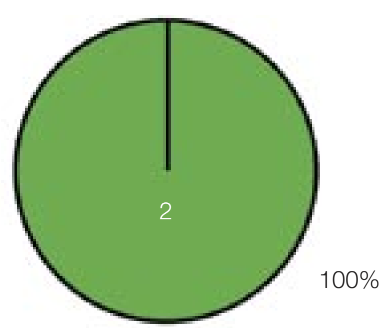
The cost of performance for Strategic Goal 5 in FY 2006 was $44.00 million.

Outcome Ratings



Under Strategic Goal 5, NASA is on track to achieve both Outcomes.

APG Ratings



Under Strategic Goal 5, NASA achieved both APGs.

Outcome 5.1: Develop and demonstrate a means for NASA to purchase launch services from emerging launch providers.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

During FY 2006, NASA established the Commercial Crew and Cargo Program Office at the Johnson Space Center to manage NASA's COTS project. NASA will pursue commercial partnerships with private industries through COTS to develop and demonstrate the vehicles, systems, and operations needed to transport cargo and crew to and from the International Space Station (ISS).

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SFS4 Green	Define and provide space transportation requirements for future human and robotic exploration and development of space to all NASA and other government agency programs pursuing improvements in space transportation.	5SFS19 Green	None	None

Outcome 5.2: By 2010, demonstrate one or more commercial space services for ISS cargo and/or crew transport.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

In FY 2006, NASA signed Space Act Agreements with SpaceX and Rocketplane–Kistler stating that the two companies would develop reliable, cost-effective options for delivering cargo to the ISS as defined by NASA in the COTS Service Requirements Document. As a first step, NASA and these new Agency partners agreed on scheduled milestones, including demonstrations of the vehicles as early as 2008 through 2010. NASA will continue to work closely with these companies to develop their launch capabilities.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ISS2 Green	Downselect transportation service providers from FY 2005 ISS Cargo Acquisition RFP.	5ISS7 Yellow	None	None

Strategic Goal 6 *Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.*

Missions to the Moon in the 21st century will be vastly different from the Apollo missions. Future missions will carry more crewmembers, expand the range of lunar landing sites, and increase the length of time astronauts spend exploring the lunar surface. Future explorers also will experiment with using lunar resources (e.g., possible water ice located deep within lunar craters) to reduce the amount of supplies that must be brought from Earth and to support an extended human presence on the Moon.

In November 2005, Johnson Space Center's Robonaut (foreground) performs a mock weld while Ames Research Center's K10 robot assists two spacesuited crewmembers inspecting a previously welded seam. This activity tested human–robot interactions and the two robots' ability to work together autonomously for assembly and maintenance, important capabilities for future lunar exploration. (NASA)

To achieve Strategic Goal 6, NASA will leverage partnerships with industry and the international space community to acquire next-generation technologies for life support, communications and navigation, radiation shielding, power generation and storage, propulsion, and resource extraction and processing.

In FY 2006, NASA began laying the foundation for the lunar return program by focusing Agency research on robotic reconnaissance explorers, surface nuclear power systems, and advanced communications systems. These technologies will support the lunar return program and will evolve and be adapted to support future Mars missions.

Risks to Achieving Strategic Goal 6

NASA faces a myriad of technological challenges and risks in returning humans to the Moon. Every system, from the Constellation Systems that will transport humans to the Moon to the surface nuclear power systems that will power lunar outposts, will need to work seamlessly, reliably, and have back-up capabilities to assure the safety of lunar crews. Like all research and development work, these initiatives will confront technological challenges and unpredictable breakthroughs that could interfere with project schedules and increase development costs. NASA will adjust schedules and cost estimates as the projects progress.

Resources, Facilities, and Major Assets

NASA will test components of the Lunar Reconnaissance Orbiter (LRO) in the Goddard Space Flight Center's Thermal Vacuum Chamber, which simulates the harsh space environment. After development and extensive testing, engineers at the Kennedy Space Center will prepare the LRO and the Lunar Crater Observation and Sensing Satellite (LCROSS) for launch.

NASA is using several Agency laboratories and facilities to conduct research contributing to Outcome 6.2:

- The Ames Research Center's Intelligent Systems Division develops software and engineering systems to make rovers, robots, and autonomous vehicles more adaptable, robust, and capable. The intelligent systems designed at Ames will play an integral role in robotic precursor missions and in creating robotic assistants for human explorers.
- NASA will test large systems at the Johnson Space Center's two Large Thermal Vacuum Chambers, which can simulate the lunar pole environment. Johnson's Automation, Robotics, and Simulation Division will integrate robotic systems into test technologies for analysis, testing, and verification at Johnson's various laboratories.

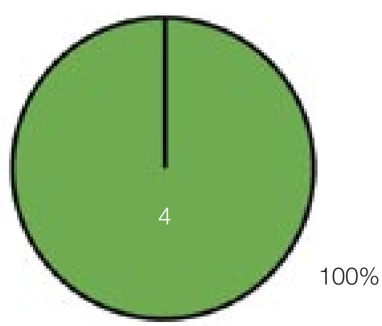
- The Glenn Research Center's Aerospace Flight Battery System Program will develop improved batteries to support in-space and surface operations.

NASA is conducting most of the work for the Prometheus Power and Propulsion project contributing to Outcome 6.3 at the Glenn Research Center and Marshall Space Flight Center. NASA will use Glenn's Solar Thermal Vacuum Facility–Tank 6, which can simulate a range of space environments, to develop the Technology Demonstration Unit, used to study and resolve system integration issues. NASA then will use Marshall's Early Flight Fission Test Facility to test the reactor simulator portion of the Technology Demonstration Unit. The Early Flight Fission Test Facility allows engineers to test aspects of nuclear reactors under non-nuclear conditions.

NASA's extensive communications networks are anchored by four major elements: the Tracking and Data Relay Satellite (TDRS) system, a constellation of satellites that provide in-flight communications with spacecraft operating in low Earth orbit; the Space Network complexes that relay data from TDRS; the NASA Integrated Services Network, which enables communications between all Agency locations; and the Deep Space Network, an international network of antennas that support NASA's Earth-orbiting and interplanetary missions. The Space Operations Mission Directorate's Space Communications Program is developing a new space communications architecture that will support the Agency's exploration and science missions through 2030, as specified under Outcome 6.4.

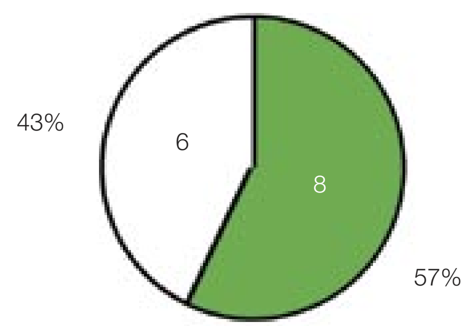
The cost of performance for Strategic Goal 6 in FY 2006 was $665.26 million.

Outcome Ratings



Under Strategic Goal 6, NASA is on track to achieve all 4 Outcomes.

APG Ratings



Under Strategic Goal 6, NASA achieved 8 of 14 APGs.

Outcome 6.1: By 2008, launch a Lunar Reconnaissance Orbiter (LRO) that will provide information about potential human exploration sites.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA's LRO mission, to be launched in 2008, will map the lunar surface to identify optimal landing sites, search for potential resources, and characterize surface radiation levels. LRO's laser altimeter will be able to peer into permanently shadowed craters at the lunar poles to map terrain while the Lunar Exploration Neutron Detector (LEND), an instrument that detects chemical signatures, and Diviner Lunar Radiometer Experiment, which maps the lunar surface temperature, search for evidence of polar ice. Craters on the lunar poles are particularly important for exploration due to the possible presence of water ice.

Additional LRO capabilities include the following:

- Provide a Digital Elevation Model (DEM), accurate to one meter vertically and 50 meters horizontally. The DEM also will provide the local slope, necessary for safe landing;

- Acquire high-resolution photographs (better than one-meter resolution) of potential landing sites, which NASA will assess for hazards and changing lighting conditions;
- Characterize the terrain, including surface roughness and rock abundance using the laser altimeter or reflected ultraviolet light;
- Characterize potential resources and lighting conditions, necessary to control the effectiveness and utility of solar power systems; and
- Support the assessment of biological risks from radiation levels.

In this artist's impression, the Shepherding Spacecraft waits in the foreground while the Centaur heads toward the Moon's south polar region. (NASA)

During FY 2006, NASA completed the mission's preliminary design review. In July, NASA awarded a launch services contract for LRO to Lockheed Martin Commercial Launch Services, Inc. LRO will launch aboard a Lockheed Martin Atlas V rocket in late 2008.

In September 2006, NASA began the program design review for the LCROSS mission that will fly with LRO. As LCROSS approaches the Moon's south polar region, it will split into two vehicles: the Shepherding Spacecraft and the Centaur Upper Stage. Centaur will impact a crater in the south polar region, sending up a plume of debris. The Shepherding Spacecraft will fly through the plume, and instruments on the spacecraft will analyze the cloud to look for signs of water and other compounds.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SSE1 Green	Complete Lunar Reconnaissance Orbiter (LRO) Preliminary Design Review (PDR).	None	None	None

Outcome 6.2: By 2012, develop and test technologies for in-situ resource utilization, power generation, and autonomous systems that reduce consumables launched from Earth and moderate mission risk.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

NASA is developing the necessary tools, technologies, and capabilities to support the Agency's lunar return program: producing oxygen from lunar soil, creating advanced rovers for surface mobility, advancing concepts for cryogenic propellant storage, developing propulsion systems that use propellants created from lunar surface resources, and improving radiation-hardened microelectronics to reduce mission risk.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESRT1 Green	Identify and test technologies to enable affordable pre-positioning of logistics for human exploration missions. Technology development includes high-power electric thrusters and high efficiency solar arrays for solar electric transfer vehicles, and lightweight composite cryotanks and zero boil-off thermal management for in-space propellant depots.	None	None	None
6ESRT2 White	Identify and test technologies to enable in-space assembly, maintenance, and servicing. Technology development includes modular truss structures, docking mechanisms, micro-spacecraft inspector, intelligent robotic manipulators, and advanced software approaches for telerobotic operations.	None	None	None
6ESRT3 Green	Identify and test technologies to reduce mission risk for critical vehicle systems, supporting infrastructure, and mission operations. Technology development includes reconfigurable and radiation tolerant computers, robust electronics for extreme environments, reliable software, and intelligent systems health management.	None	None	None

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESRT4 Green	Design and test technologies for in situ resource utilization that can enable more affordable and reliable space exploration by reducing required launch mass from Earth, and by reducing risks associated with logistics chains that supply consumables and other materials. Technology development includes excavation systems, volatile material extraction systems, and subsystems supporting lunar oxygen and propellant production plants.	None	None	None
6ESRT5 White	Validate the ESMD research and technology development needs and opportunities by implementing a Quality Function Deployment process, and use the results to guide ESR&T program investment decisions.	None	None	None
6ESRT6 Green	Develop and analyze affordable architectures for human and robotic exploration system and mission options using innovative approaches such as modular systems, in-space assembly, pre-positioning of logistics, and utilization of in-situ resources.	None	None	None
6ESRT7 White	Identify and define technology flight experiment opportunities to validate the performance of critical technologies for exploration missions.	None	None	None
6ESRT8 Green	Identify and test technologies to reduce the costs of mission operations. Technology development includes autonomous and intelligent systems, human–automation interaction, multi-agent teaming, and space communications and networking.	None	None	None

Performance Shortfalls

6ESRT2, 6ESRT5, and 6ERT7: NASA canceled all work related to in-space assembly (6ESRT2) and the In-space Technology Experiments (InSTEP) project (6ESRT7). NASA also decided that the Quality Function Deployment Process was no longer needed.

Outcome 6.3: By 2010, identify and conduct long-term research necessary to develop nuclear technologies essential to support human–robotic lunar missions and that are extensible to exploration of Mars.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

During FY 2006, NASA reformulated the Prometheus Power and Propulsion Program to better align it with the Vision for Space Exploration and available Agency resources by focusing the program on surface nuclear power system development. Therefore, most of the program's FY 2006 activities revolved around closing out nuclear electric propulsion efforts. In addition, program staff began reformulating program objectives and reviewed lessons learned and various studies to aid them in transitioning to a long-term research and technology program. NASA and U.S. Department of Energy (DoE) power experts began the Affordable Fission Surface Power System Study. NASA anticipates a report in mid-FY 2007.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6PROM1 White	Following completion of the Prometheus Analysis of Alternatives, complete space nuclear reactor conceptual design.	None	None	None
6PROM2 White	Verify and validate the minimum functionality of initial nuclear electric propulsion (NEP) spacecraft capability.	None	None	None
6PROM3 White	Complete component level tests and assessments of advanced power conversion systems.	None	None	None

Performance Shortfalls

6PROM1, 6PROM2, and 6PROM3: NASA canceled these APGs due to a program focus shift from nuclear electric propulsion development to surface nuclear power systems development. NASA will provide appropriately revised APGs for Outcome 6.3 in the FY 2007 Performance Plan Update to accompany the Agency's FY 2008 Budget Estimates. Meanwhile, the Prometheus project will continue work toward achieving Outcome 6.3 on schedule.

Outcome 6.4: Implement the space communications and navigation architecture responsive to Science and Exploration mission requirements.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

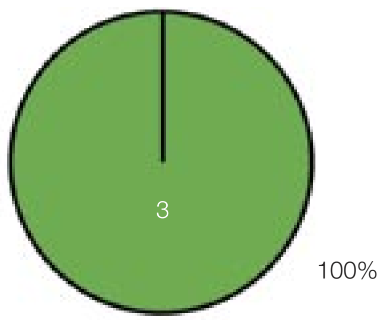
NASA is developing a Space Communications Architecture that will provide the necessary communication and navigation services for the Agency's space exploration and science missions through 2030. This architecture will provide communication services to space missions operating anywhere in the solar system and will feature clustered networking services at Earth, the Moon, and Mars to provide faster, more reliable communication connections. In March 2006, the Space Communications Architecture Working Group presented the proposed architecture, including details about network connections, security protocols, radio frequency-spectrum allocations, and navigation support functions, to the Agency's Strategic Management Council. Agency management is reviewing the implementation plans for this architecture that NASA expects to have operational by 2014.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6SFS1 Green	Establish the Agency-wide baseline space communications architecture, including a framework for possible deep space and near Earth laser communications services.	5SFS8 Green	4SFS8 Green	None
6SFS3 Green	Achieve at least 95 percent of planned data delivery for the International Space Station, each Space Shuttle mission, and low Earth orbiting missions for FY 2006.	5SFS16 Blue	4SFS5 Blue	3H14 Blue

Cross-Agency Support Programs

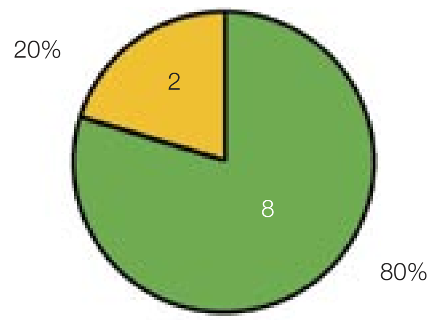
NASA created Cross-Agency Support Programs—introduced in the FY 2007 Budget Estimates and included in the FY 2006 Performance Plan, reported on in this document—to focus on several ongoing activities that function across all Mission Directorates and Mission Support Areas to serve NASA's Mission and to establish an improved way of managing NASA's unique facilities.

Outcome Ratings



Under Cross-Agency Support Programs, NASA is on track to achieve all 3 Outcomes.

APG Ratings



Under Cross-Agency Support Programs, NASA achieved 8 of 10 APGs.

Education

Achieving the Vision for Space Exploration will require a workforce that is equipped with the skills and capabilities necessary to meet future mission needs. In the near-term, NASA will meet these needs by training current employees and bringing new employees with new capabilities into the Agency. To meet long-term needs, NASA's Education programs will help create the workforce of the future by inspiring students at all levels to pursue careers in science, technology, engineering, and mathematics (STEM), providing professional-development opportunities to STEM teachers, and developing interesting STEM content for the classroom, the Web, and informal learning environments like museums and community-based organizations.

A young explorer builds a rocket at Astro Camp hosted by the Stennis Space Center. NASA's Centers hold events, provide education opportunities, and develop projects that help NASA's Education programs achieve their objectives. (NASA)

Outcome ED–1: Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's Strategic Goals through a portfolio of programs.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

In FY 2006, NASA redesigned the Agency's Education programs to maximize returns on education investments. NASA awarded over 10,000 competitive scholarships, fellowships, and research opportunities for graduates, undergraduates, underprivileged students, and faculty in STEM disciplines. The Agency uses these scholarships, fellowships, and research opportunities to build student interest in NASA and to increase partnerships with informal and formal education providers. Education program managers now are tracking students who receive scholarships or fellowships to determine their level of involvement with NASA after their formal education is complete. This tracking initiative also will help identify opportunities for improving the Agency's education programs.

To provide a historical base and additional lessons learned, NASA also is planning a retrospective survey of current employees who participated in NASA education programs.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ED3 Green	Award approximately 1,000 competitive scholarships, fellowships, and research opportunities for higher education students and faculty in STEM disciplines. (APG revised: awards reduced from 1,500 to 1,000 based on FY 2006 Appropriation.)	None	None	None
6ED4 Yellow	Complete a retrospective longitudinal study of student participants to determine the degree to which participants entered the NASA workforce or other NASA-related career fields.	None	None	None
6ED5 Green	Collect, analyze, and report longitudinal data on student participants to determine the degree to which participants enter the NASA workforce or other NASA-related career fields.	None	None	None
6ED6 Green	Award approximately 250 competitive scholarships, internships, fellowships, and research opportunities for underrepresented and underserved students, teachers, and faculty in STEM disciplines. (APG revised: awards reduced from 1,100 to 250 based on FY 2006 Appropriation.)	None	None	None
6ED7 Yellow	Provide approximately 50 grants to enhance the capability of approximately 25 underrepresented and underserved colleges and universities to compete for and conduct basic or applied NASA-related research. (APG revised: grants reduced from 350 to 50, and the number of colleges and universities awarded reduced from 100 to 25, based on FY 2006 Appropriation.)	None	None	None

Performance Shortfalls

6ED4: NASA did not complete the retrospective study of student participants' entry into the NASA workforce, because the number of employees hired within the past decade was higher than expected. NASA will complete the survey in FY 2007.

6ED7: NASA exceeded the number of institutions during FY 2006, but did not achieve the targeted number of grant awards.

Advanced Business Systems (Integrated Enterprise Management Program)

NASA's Integrated Enterprise Management Program (IEMP) is transforming the Agency's business systems, processes, and procedures to improve financial management and accountability and to increase efficiency and cost savings across the Agency. IEMP projects currently underway include the following:

- eTravel, which will replace NASA's Travel Manager system with an end-to-end travel management system;
- The Contract Management Module, which will provide a comprehensive tool to support contract writing, contract administration, procurement workload management, and data reporting/management for NASA;
- The Human Capital Information Environment, which will provide online access to near real-time human capital information;
- The Integrated Asset Management, Property, Plant, and Equipment module, which will focus on the accountability, valuation, and tracking of internal-use software, Theme assets, and personal property that is either NASA-owned/NASA-held or NASA-owned/contractor-held;
- The SAP Version Update to enhance the Agency's Core Financial system functionality; and
- The Aircraft Management Module, which will provide an integrated toolset that will enhance the management and oversight of NASA's mission management aircraft, mission support aircraft, and research aircraft.

Assessments

In FY 2006, the Office of Management and Budget (OMB) rated IEMP as "Moderately Effective" using the Program Assessment Rating Tool (PART). IEMP received the following scores in the four PART assessment areas:

- Program Purpose and Design—80% (moderately effective)
- Strategic Planning—100% (effective)
- Program Management—88% (effective)
- Program Results/Accountability—67% (adequate)

The scores indicate that NASA has set valid annual and long-term goals for IEMP and established effective processes for program management and financial oversight. However, the Agency should revise some of the accountability processes to ensure consistent program effectiveness.

Outcome IEM–2: Increase efficiency by implementing new business systems and reengineering Agency business processes.

FY 2006	FY 2005	FY 2004	FY 2003
Green	None	None	None

Major FY 2006 efforts for IEMP include the Project Management Information Improvement (PMII) project and the Agency Labor Distribution System (ALDS). The PMII Project enhanced the Core Financial system by implementing policy adjustments and mapping data between financial structures and technical work breakdown structures. The PMII project also improved the transmission of cost reporting information to project managers. NASA used ALDS to replace legacy Center labor distribution systems with an Agency labor distribution system and standardized processes based on new policies and procedures approved by NASA's Chief Financial Officer.

FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6IEM1 Green	Deliver an analysis and recommendations for long-term solutions to account for and maintain the Agency's assets defined as Property Plant & Equipment and Operating Materials and Supplies (encompasses the major functions of Environmental, Facilities, Logistics, and all related financial activities).	None	None	None

Innovative Partnerships Program

To achieve the Vision for Space Exploration in an affordable and sustainable manner, NASA partners with industry and academia to leverage outside investments and expertise while giving the Agency's partners an economic incentive to invest in NASA programs. NASA's Innovative Partnerships Program (IPP) attracts and maintains Agency business partnerships and manages both intellectual property rights and technology transfer processes.

IPP serves all four Mission Directorates across NASA's 10 Centers. Mission Directorates outline their technology needs, and IPP helps satisfy those needs through research and development partnerships with industry and academia, technology transfer with non-profit research institutions like universities, and commercialization opportunities to help entrepreneurs develop NASA technologies for the marketplace.

NASA's IPP managers spent much of FY 2006 examining precedents and establishing protocols that will help the Agency partner with emerging space industry businesses.

Outcome IPP–1: Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects.

FY 2006	FY 2005	FY 2004	FY 2003
Green	Green	Blue	None

In FY 2006, IPP established the Seed Fund Initiative. This initiative will enhance NASA's ability to meet mission technology goals by providing "bridge" funding between NASA and the Agency's partners. This initiative also will make programs more affordable by funding partnerships in which all parties involved share the costs, risks, benefits, and outcomes.

NASA also formed a partnership with Red Planet Capital, Inc., to help advance the Agency's technological position through the venture capital community. Through this contract, NASA has established a strategic venture capital fund to promote the future availability of technologies with government and commercial applications that meet future mission requirements.

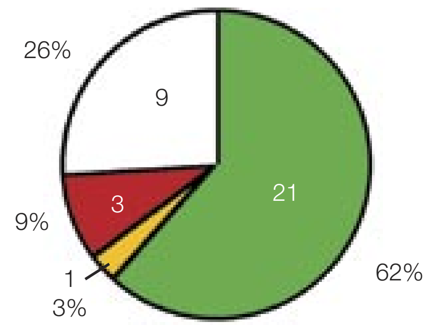
FY 2006 Annual Performance Goal		FY 2005	FY 2004	FY 2003
6ESRT9 Green	Complete 50 technology transfer agreements with the U.S. private sector for transfer of NASA technologies, hardware licenses, software usage agreements, facility usage agreements, or Space Act Agreements.	5HRT18 Green	4HRT6 Green	None
6ESRT10 Green	Develop 40 industry partnerships that will add value to NASA missions.	5HRT13 Green	4HRT9 Blue	None
6ESRT11 Green	Establish at least twelve new partnerships with major ESMD R&D programs or other NASA organizations.	None	None	None
6ESRT12 Green	Award Phase III contracts or venture capital funds to 4 SBIR firms to further develop or produce technology for U.S. industry or government agencies.	5HRT14 Green	4HRT10 Green	None

Efficiency Measures

NASA uses the Agency's Strategic Goals, multi-year Outcomes, and Annual Performance Goals (APGS) to measure performance progress in program areas. NASA also uses Efficiency Measure APGs to track the Agency's performance in a number of management areas, including cost, schedule, and project completion.

NASA organizes the Efficiency Measure APGs by budget Theme to emphasize and encourage individual program accountability. The following table documents the Agency's performance against these metrics for FY 2006.

APG Ratings



Under Efficiency Measures, NASA achieved 21 of 34 APGs.

FY 2006 Performance Measure		FY 2005	FY 2004	FY 2003
Aeronautics Technology				
6AT12 Green	Deliver at least 90% of scheduled operating hours for all operations and research facilities.	None	None	None
6AT13 Green	Increase the annual percentage of research funding subject to external peer review prior to award.	None	None	None
Education				
6ED11 Green	Collect, analyze, and report the percentage of grantees that annually report on their accomplishments.	None	None	None
6ED12 Red	Peer review and competitively award at least 80%, by budget, of research projects.	5ED19 Green	4ED24 Green	None
Constellation Systems				
6CS5 Green	Complete all development projects within 110% of the cost and schedule baseline.	None	None	None
6CS6 Green	Increase annually the percentage of ESR&T and HSR&T technologies transitioned to Constellation Systems programs.	None	None	None
Exploration Systems Research and Technology				
6ESRT13 White	Complete all development projects within 110% of the cost and schedule baseline.	None	None	None
6PROM4 White	Complete all development projects within 110% of the cost and schedule baseline.	None	None	None
6ESRT14 White	Peer review and competitively award at least 80%, by budget, of research projects.	5HRT15 Green	4HRT13 Green	None
6ESRT15 White	Reduce annually, the time to award competed projects, from proposal receipt to selection.	None	None	None
6PROM5 White	Reduce annually, the time to award competed projects, from proposal receipt to selection.	None	None	None
Human Systems Research and Technology				
6HSRT21 Green	Deliver at least 90% of scheduled operating hours for all operations and research facilities.	5BSR19 Green	4RPFS11 Green	None
6HSRT22 White	Increase annually, the percentage of grants awarded on a competitive basis.	None	None	None
6HSRT23 Green	Peer review and competitively award at least 80%, by budget, of research projects.	5BSR20 Green	4BSR19 4PSR11 Green	None
6HSRT247 Green	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	None

FY 2006 Performance Measure		FY 2005	FY 2004	FY 2003
Earth–Sun System				
6ESS24 Red	Complete all development projects within 110% of the cost and schedule baseline.	5SEC14 Red	4ESS1 Green	None
6ESS25 Green	Deliver at least 90% of scheduled operating hours for all operations and research facilities.	5SEC15 Yellow	None	None
6ESS26 Green	Peer-review and competitively award at least 80%, by budget, of research projects.	5SEC16 Green	4ESA8 Green	None
6ESS27 Green	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	None
Solar System Exploration				
6SSE29 Red	Complete all development projects within 110% of the cost and schedule baseline.	5SSE15 Yellow	4SSE1 Yellow	None
6SSE30 Green	Deliver at least 90% of scheduled operating hours for all operations and research facilities.	5SSE16 Green	None	None
6SSE31 Green	Peer-review and competitively award at least 80%, by budget, of research projects.	5SSE17 Green	4SSE2 Green	None
6SSE32 Green	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	None
The Universe				
6UNIV22 White	Complete all development projects within 110% of the cost and schedule baseline.	5ASO13 Green	4ASO1 White	None
6UNIV23 Green	Deliver at least 90% of scheduled operating hours for all operations and research facilities.	5ASO14 Yellow	None	None
6UNIV24 Green	Peer-review and competitively award at least 80%, by budget, of research projects.	5ASO15 Green	4SEU2 4ASO2 Green	None
6UNIV25 Yellow	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	None	None	None
International Space Station				
6ISS5 Green	Complete all development projects within 110% of the cost and schedule baseline.	5ISS8 Green	4ISS7 Green	None
6ISS6 Green	Deliver at least 90% of scheduled operating hours for all operations and research facilities.	5ISS9 Green	None	None
Space Flight Support				
6SFS2 Green	Maintain NASA success rate at or above a running average of 95 percent for missions on the FY 2006 Expendable Launch Vehicle (ELV) manifest.	5SFS15 Green	4SFS4 Green	3H03 Blue
6SFS7 White	Complete all development projects within 110% of the cost and schedule baseline.	5SFS21 Green	4SFS14 Green	None
6SFS8 Green	Deliver at least 90% of scheduled operating hours for all operations and research facilities.	5SFS22 Green	4RPFS11 Green	None
Space Shuttle				
6SSP2 White	Complete all development projects within 110% of the cost and schedule baseline.	5SSP4 Yellow	4SSP5 Green	None
6SSP3 Green	Deliver at least 90% of scheduled operating hours for all operations and research facilities.	5SSP5 Green	None	None

NASA's FY 2006 Performance Improvement Plan

The following table reports on APGs that NASA was unable to achieve fully in FY 2006 and multi-year Outcomes that NASA may not or will not achieve by the Outcome's targeted completion date. The table is organized by Strategic Goals and Sub-goals, with Efficiiency Measures at the end organized by budget Themes. For each performance shortfall, the table includes ia explanation of the specific performance problem and NASA's plan and schedule to achieve the measure in the future or an explanation of why the measure was canceled by management.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Strategic Goal 1: Fly the Shuttle as safely as possible until its retirement, not later than 2010.				
Outcome 1.1	Assure the safety and integrity of the Space Shuttle workforce, systems and processes, while flying the manifest.	Yellow	The Space Shuttle Program reported and investigated three major incidents in FY 2006. Two Type-B mishaps include damage to *Discovery*'s robotic manipulator arm caused while crews were servicing the Shuttle in the Orbiter Processing Facility hangar, and damage to *Atlantis*' coolant loop accumulator due to over-pressurization. NASA also reported a personnel injury at Kennedy Space Center's Launch Complex 39A.	NASA convened a mishap investigation board for each incident. The boards are on schedule to complete their investigations and deliver their final reports in FY 2007.
6SSP1	Achieve zero Type-A (damage to property at least $1M or death) or Type-B (damage to property at least $250K or permanent disability or hospitalization of 3 or more persons) mishaps in 2006.	Red	The Space Shuttle Program reported and investigated three major incidents in FY 2006. Two Type-B mishaps include damage to *Discovery*'s robotic manipulator arm caused while crews were servicing the Shuttle in the Orbiter Processing Facility hangar, and damage to *Atlantis*' coolant loop accumulator due to over-pressurization. NASA also reported a personnel injury at Kennedy Space Center's Launch Complex 39A.	NASA convened a mishap investigation board for each incident. The boards are on schedule to complete their investigations and deliver their final reports in FY 2007.
Strategic Goal 2: Complete the International Space Station in a manner consistent with NASA's International partner commitments and the needs of human exploration.				
ISS3 (Outcome 2.1)	Provide 80 percent of FY 2006 planned on-orbit resources and accommodations to support research, including power, data, crew time, logistics and accommodations.	Yellow	NASA was unable to meet the original goal of regularly scheduled Shuttle flights throughout FY 2006 due to foam issues on the external tank. While these issues were resolved, NASA did not launch the Shuttle until July 2006—10 months after the start of FY 2006. Shuttle flight delays reduced actual upmass and volume capabilities.	Shuttle schedules have been adjusted for FY 2007, but these schedules always are subject to change as circumstances warrant.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Sub-goal 3A: Study Earth from space to advance scientific understanding and meet societal needs.				
6ESS6 (This APG is repeated for Outcomes 3A.1, 3A.2, 3A.3, 3A.4, 3A.5, and 3A.6)	Improve level of customer satisfaction as measured by a baselined index obtained through the use of annual surveys.	Yellow	The FY 2006 EOSDIS customer satisfaction survey, performed by the Claes-Fornell Institute (CFI), produced a score of 74, a decrease from a high score of 78 in 2005, but above the federal government average of 71.	Consistent with past practice, CFI provided detailed survey data, which will enable NASA to focus its ongoing efforts to improve Earth science data, information, and services provision. Specific attention will be given to ways of maintaining and improving customer satisfaction while also focusing on the potentially conflicting, but very important, goals of increasing the number and types of users and new data types.
Outcome 3A.4 (With the addition of 6ESS22, APGs are the same as Outcome 3A.1)	Progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability.	Yellow	Research results in 2006 enabled significant progress in understanding and modeling the water cycle. However, delays in the development and launch of the Global Precipitation Measurement (GPM) mission and the NPOESS Preparatory Project (NPP) will impact NASA's progress in this science focus area.	NASA will develop an Earth science roadmap based on the mission priorities established in the decadal survey, available in November 2006. The Agency will use the roadmap to re-baseline the support available to GPM by the end of 2006 and provide finalized support by the spring of 2007. Program funding supports the NPP 2009 launch date.
6ESS22 (Outcome 3A.4)	Complete Global Precipitation Measurement (GPM) Confirmation Review.	White	NASA management deferred the GPM mission. NASA will develop an Earth science roadmap based on the mission priorities established in the decadal survey expected from the National Research Council in December 2006. The Agency will use the roadmap to re-baseline the support available to GPM by the spring 2007.	N/A
Outcome 3A.5 (With the addition of 6ESS23, APGs are the same as Outcome 3A.1)	Progress in understanding the role of oceans, atmosphere, and ice in the climate system and in improving predictive capability for its future evolution.	Yellow	Cost overruns and technical difficulties delayed the NPOESS Preparatory Project (NPP) mission, which will impact NASA's progress in this science focus area.	Program funding supports the NPP 2009 launch date.
6ESS23 (Outcome 3A.5)	Complete Operational Readiness Review for the NPOESS Preparatory Project (NPP).	Red	Due to late delivery of the key Visible/Infrarerd Imager/Radiometer Suite (VIIRS) instrument from a program partner, NASA moved the Operational Readiness Review for NPP to September 2009.	NASA management postponed this review until FY 2008.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Sub-goal 3B: Understand the Sun and its effects on Earth and the solar system.				
6ESS21 (Outcome 3A.7)	Benchmark the assimilation of observations and products in decision support systems serving applications of national priority. Progress will be evaluated by the Committee on Environmental and National Resources.	Yellow	NASA completed this benchmarking in support of such areas as agricultural efficiency, air quality, aviation, disaster management, and public health. However, the external evaluation was postponed, primarily due to delays related to committee members' schedules.	The National Research Council will finalize its evaluation by spring 2007. Results will be available through *http://aiwg.gsfc.nasa.gov*, and will be addressed in the FY 2007 Performance and Accountability Report.
6ESS16 (This APG is repeated for Outcome 3B.2 and 3B.3)	Successfully launch the Solar Terrestrial Relations Observatory (STEREO).	Yellow	NASA postponed the STEREO launch due to problems with the Delta II launch vehicle 2nd stage tanks.	STEREO launched in October 2006.
Sub-goal 3C: Advance scientific knowledge of the solar system, search for evidence of life, and prepare for human exploration.				
6SSE27 (Outcome 3C.1)	Successfully launch Dawn spacecraft.	Yellow	NASA delayed the launch of Dawn due to technical difficulties.	Dawn underwent reviews to address technical and cost issues and the launch is currently scheduled for June 2007.
6SSE28 (Outcome 3C.1)	Successfully complete MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) flyby of Venus.	White	This measure was erroneously included in the FY 2006 Performance Plan Update. MESSENGER's flyby of Venus was always scheduled for October 2006 (FY 2007).	N/A
6SSE9 (Outcome 3C.2)	Successfully demonstrate progress in understanding why the terrestrial planets are so different from one another. Progress toward achieving outcomes will be validated by external expert review.	Yellow	External reviewers deemed all of the evidence presented for this APG as positive. However, since the evidence was based on preliminary results, the external reviewers rated the progress on this goal as less robust than the progress seen in other areas of planetary science.	NASA-funded investigators are participating in the European Space Agency's Venus Express mission. Venus Express, launched in November 2005, arrived at Venus in April and is orbiting the planet, studying its atmosphere in detail. In addition, under the Discovery Program 2006 Announcement of Opportunity, NASA selected for concept study a return to Venus mission. Vesper, the Venus Chemistry and Dynamics Orbiter, proposes to significantly advance understanding of the atmospheric composition and dynamics of Venus, especially its photochemistry. Successful completion of the concept study would allow continuation into a full design effort.
6SSE19 (Outcome 3C.2)	Successfully demonstrate progress in understanding the character and extent of prebiotic chemistry on Mars. Progress toward achieving outcomes will be validated by external expert review.	Yellow	The lack of direct measurements has limited NASA's progress in this area. While laboratory and field research enabled some progress, direct measurements have not been made since the Viking missions in the 1970s.	The next two Mars missions, Phoenix, to be launched in 2007, and the Mars Science Laboratory, to be launched in 2009, have technology to directly measure organic compounds and potentially elucidate the character and extent of prebiotic chemistry.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Sub-goal 3C: Advance scientific knowledge of the solar system, search for evidence of life, and prepare for human exploration. (Continued)				
6SSE20 (Outcome 3C.3)	Successfully demonstrate progress in searching for chemical and biological signatures of past and present life on Mars. Progress toward achieving outcomes will be validated by external expert review.	Yellow	Although the current missions at Mars are extremely capable and have exceeded expectations, NASA did not design the instrumentation to address this objective.	The next two Mars missions, Phoenix, to be launched in 2007, and the Mars Science Laboratory, to be launched in 2009, have the capability to measure organic compounds and mineralogy to search for chemical and biological signatures of life.
Sub-goal 3D: Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.				
6UNIV19 (Outcome 3D.1)	Complete Gamma-ray Large Area Space Telescope (GLAST) Spacecraft Integration and Test (I&T).	Yellow	NASA postponed the GLAST I&T due to electronic parts problems and the need to change release mechanisms on the spacecraft.	Spacecraft I&T is scheduled currently for early FY 2007.
6UNIV20 (This APG is repeated for Outcome 3D.1, 3D.2, and 3D.3)	Complete James Webb Space Telescope (JWST) Mission Preliminary Design Review (PDR).	Red	NASA revised the JWST schedule in response to growth in the cost estimate that NASA had identified in FY 2005.	NASA moved the launch date to 2013. As a result, NASA will hold the PDR in March 2008.
Outcome 3D.2	Progress in understanding how the first stars and galaxies formed, and how they changed over time into the objects recognized in the present universe.	Yellow	NASA made scientific progress toward this Outcome, but delays in the development and launch of JWST will impact future results.	The James Webb Space Telescope has undergone a comprehensive project replan. The mission is scheduled to launch in 2013.
6UNIV16 (Outcome 3D.2)	Successfully demonstrate progress in discovering how the interplay of baryons, dark matter, and gravity shapes galaxies and systems of galaxies. Progress toward achieving outcomes will be validated by external expert review.	Yellow	The external review found that NASA made limited progress toward this performance goal. Comments included the opinion that this goal, as written, was too challenging or ambitious, and suggested that it be dropped. Reviewers noted that APGs 6UNIV14 and 6UNIV17 also will yield information about the interplay of baryons, dark matter, and gravity in the evolution of galaxies.	NASA will change this APG in FY 2007.
Outcome 3D.3	Progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems.	Yellow	NASA made scientific progress on this Outcome, but future results will be impacted by delays in the SOFIA and JWST programs. These two new facilities are expected to make significant progress in star formation studies because of their mid- and far-infrared observation capabilities.	See SOFIA (6UNIV18) and JWST (6UNIV20) performance measures.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Sub-goal 3D: Discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets. (Continued)				
6UNIV18 (Outcome 3D.3)	Complete Stratospheric Observatory for Infrared Astronomy (SOFIA) Airworthiness Flight Testing.	Red	NASA chartered a review in March 2006 to document the status of the SOFIA Program and to identify and analyze options. NASA determined the most appropriate course of action is to continue the SOFIA Program with significant program restructuring, including transferring the direct management of SOFIA's airborne system (aircraft and telescope) development and extensive flight testing to Dryden Flight Research Center.	NASA will transfer the SOFIA airborne system to DFRC in early 2007 to initiate the flight test program. An operational readiness review will follow completion of this extensive flight test program in 2010.
Outcome 3D.4	Progress in creating a census of extra-solar planets and measuring their properties.	Yellow	NASA made scientific progress on the Outcome, but delays in the development and deployment of next generation missions will impact further results.	Kepler I&T is scheduled to begin in June 2007, with a launch readiness date of November 2008. NASA deferred the Space Interferometry Mission (SIM) beyond the budget planning period.
6UNIV5 (Outcome 3D.4)	Successfully demonstrate progress in determining how common Earth-like planets are and whether any might be habitable. Progress toward achieving outcomes will be validated by external expert review.	Yellow	Continued delays of SIM and Kepler constitute slow progress toward achieving this goal.	Kepler I&T is scheduled to begin in June 2007, with a launch readiness date of November 2008. NASA deferred the SIM beyond the budget planning period.
6UNIV21 (Outcome 3D.4)	Begin Kepler Spacecraft Integration and Test (I&T).	Yellow	Inefficiencies, particularly with regard to work on the spacecraft's photometer, caused delays and cost impacts for the Kepler project and an inability to maintain the previous launch schedule of June 2008.	Kepler I&T is currently scheduled to begin in June 2007, with a launch readiness date of November 2008.
Sub-goal 3E: Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems.				
6AT14 (Outcome 3E.1)	Complete Aviation Safety Program restructuring activities in order to focus research efforts more precisely on the Nation's aviation safety challenges for the Next Generation Air Transportation System (2025) and beyond.	Yellow	The Aviation Safety Program delayed approval of one of its four projects: The Integrated Resilient Aircraft Controls, which develops capabilities to reduce (or eliminate) aircraft loss-of-control accidents and ensure safe flight under off-nominal conditions.	Program management expects final approval of this project during the first quarter of FY 2007.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Sub-goal 3E: Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems. (Continued)				
(Outcome 3E.1)	Utilizing a competitive peer-reviewed selection process, determine the research portfolio and partnerships to enable advances in the Aviation Safety thrust areas (Integrated Intelligent Flight Deck Technologies, Integrated Vehicle Health Management, Integrated Resilient Aircraft Controls, and Aircraft Aging and Durability.)	Yellow	The Aviation Safety Program delayed approval of one of its four projects: The Integrated Resilient Aircraft Controls, which develops capabilities to reduce (or eliminate) aircraft loss-of-control accidents and ensure safe flight under off-nominal conditions.	Program management expects final approval of this project during the first quarter of FY 2007.
6AT16 (Outcome 3E.2)	Complete Airspace Systems Program restructuring activities in order to align research efforts to address the Joint Planning and Development Office's Next Generation Air Transportation System (NGATS) capability requirements for 2025. (New APG)	Yellow	The Airspace Systems Program delayed approval of a portion of its project portfolio (the NGATS Air Traffic Management Airportal project) that will develop capabilities to increase throughput in terminal and airport domains enabling NGATS.	The approval of the NGATS Air Traffic Management Airportal Project is expected in the first quarter of FY 2007.
6AT17 (Outcome 3E.2)	Utilizing a competitive peer-reviewed selection process, determine the research portfolio and partnerships to enable advances in the Airspace Systems thrust areas (Next Generation Air Transportation Systems and Super Density Surface Management.) (New APG)	Yellow	The Airspace Systems Program delayed approval of a portion of its project portfolio (the NGATS Air Traffic Management Airportal project) that will develop capabilities to increase throughput in terminal and airport domains enabling NGATS.	The approval of the NGATS Air Traffic Management Airportal Project is expected in the first quarter of FY 2007.
6AT8 (Outcome 3E.3)	Identify and document engine configuration and noise reduction technologies needed to enable 10 dB reduction in aircraft system noise. (APG revised based on FY06 Appropriation.)	White	This APG was part of NASA's FY 2005 Vehicle Systems close-out activities. Due to Aeronautics Research Mission Directorate restructuring, this APG no longer aligns with NASA's research goals and has been canceled.	N/A
6AT11 (Outcome 3E.3)	Complete trade study of unconventional propulsion concepts for a zero-emissions vehicle.	White	This APG was part of NASA's FY 2005 Vehicle Systems close-out activities. Due to Aeronautics Research Mission Directorate restructuring, this APG no longer aligns with NASA's research goals and has been canceled.	N/A
Sub-goal 3F: By 2008, develop and test candidate countermeasures to ensure the health of humans traveling in space.				
6HSRT9 (Outcome 3F.1)	Complete renal stone countermeasure development.	Yellow	NASA researchers did not complete the renal stone countermeasure study.	Data collection from the final subject is scheduled for March 2007.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Sub-goal 3F: By 2008, develop and test candidate countermeasures to ensure the health of humans traveling in space. (Continued)				
6HSRT14 (Outcome 3F.2)	Define requirements for the Condensing Heat Exchanger Flight experiment focused on improving space condenser reliability.	White	NASA canceled the Condensing Heat Exchanger Flight experiment.	N/A
Strategic Goal 4: Bring a new Crew Exploration Vehicle into service as soon as possible after Shuttle retirement.				
6HSRT1 (Outcome 4.2)	Complete the technology trade studies for both the in-space and surface EVA suits.	White	Due to changes in the Extravehicular Activity Systems architecture, NASA canceled the APGs under Outcome 4.2. NASA will include appropriately revised APGs in the FY 2007 Performance Plan Update submitted with the Agency's FY 2008 Budget Estimates. Meanwhile, the Constellation Systems Program continues work on a single, integrated spacesuit design to support Outcome 4.2.	N/A
6HSRT2 (Outcome 4.2)	Complete the system requirements review for both the in-space and surface exploration EVA suits.	White	Due to changes in the Extravehicular Activity Systems architecture, NASA canceled the APGs under Outcome 4.2. NASA will include appropriately revised APGs in the FY 2007 Performance Plan Update submitted with the Agency's FY 2008 Budget Estimates. Meanwhile, the Constellation Systems Program continues work on a single, integrated spacesuit design to support Outcome 4.2.	N/A
Strategic Goal 6: Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations.				
6ESRT2 (Outcome 6.2)	Identify and test technologies to enable in-space assembly, maintenance, and servicing. Technology development includes modular truss structures, docking mechanisms, micro-spacecraft inspector, intelligent robotic manipulators, and advanced software approaches for telerobotic operations.	White	Throughout FY 2006, NASA made program-investment decisions based on the exploration architecture, which determined the technology priorities for NASA's lunar exploration program. Based on these findings, NASA cancelled all work related to in-space assembly (6ESRT2) and the In-space Technology Experiments (InSTEP) project (6ESRT7). NASA also decided that the Quality Function Deployment Process was no longer needed.	N/A

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Strategic Goal 6: Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations. (Continued)				
6ESRT5 (Outcome 6.2)	Validate the ESMD research and technology development needs and opportunities by implementing a Quality Function Deployment process, and use the results to guide ESR&T program investment decisions.	White	Throughout FY 2006, NASA made program-investment decisions based on the exploration architecture, which determined the technology priorities for NASA's lunar exploration program. Based on these findings, NASA canceled all work related to in-space assembly (6ESRT2) and the In-space Technology Experiments (InSTEP) project (6ESRT7). NASA also decided that the Quality Function Deployment Process was no longer needed.	N/A
6ESRT7 (Outcome 6.2)	Identify and define technology flight experiment opportunities to validate the performance of critical technologies for exploration missions.	White	Throughout FY 2006, NASA made program-investment decisions based on the exploration architecture, which determined the technology priorities for NASA's lunar exploration program. Based on these findings, NASA canceled all work related to in-space assembly (6ESRT2) and the In-space Technology Experiments (InSTEP) project (6ESRT7). NASA also decided that the Quality Function Deployment Process was no longer needed.	N/A
6PROM1 (Outcome 6.3)	Following completion of the Prometheus Analysis of Alternatives, complete space nuclear reactor conceptual design.	White	NASA canceled these APGs due to a program focus shift from nuclear electric propulsion development to surface nuclear power systems development. NASA will include appropriately revised APGs for Outcome 6.3 in the FY 2007 Performance Plan Update submitted with the Agency's FY 2008 Budget Estimates. Meanwhile, the Prometheus Program will continue work toward achieving Outcome 6.3 on schedule.	N/A
6PROM2 (Outcome 6.3)	Verify and validate the minimum functionality of initial nuclear electric propulsion (NEP) spacecraft capability.	White	NASA canceled these APGs due to a program focus shift from nuclear electric propulsion development to surface nuclear power systems development. NASA will include appropriately revised APGs for Outcome 6.3 in the FY 2007 Performance Plan Update submitted with the Agency's FY 2008 Budget Estimates. Meanwhile, the Prometheus Program will continue work toward achieving Outcome 6.3 on schedule.	N/A

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Strategic Goal 6: Establish a lunar return program having the maximum possible utility for later missions to Mars and other destinations. (Continued)				
6PROM3 (Outcome 6.3)	Complete component level tests and assessments of advanced power conversion systems.	White	NASA canceled these APGs due to a program focus shift from nuclear electric propulsion development to surface nuclear power systems development. NASA will include appropriately revised APGs for Outcome 6.3 in the FY 2007 Performance Plan Update submitted with the Agency's FY 2008 Budget Estimates. Meanwhile, the Prometheus Program will continue work toward achieving Outcome 6.3 on schedule.	N/A
Cross-Agency Support Programs: Education				
6ED4 (Outcome ED-1)	Complete a retrospective longitudinal study of student participants to determine the degree to which participants entered the NASA workforce or other NASA-related career fields.	Yellow	NASA did not complete the retrospective study of student participants' entry into the NASA workforce due to technical issues directly related to the large population of potential survey respondents.	NASA is adjusting the survey instrument and protocol and the survey will be completed in FY 2007.
6ED7 (Outcome ED-1)	Provide approximately 50 grants to enhance the capability of approximately 25 underrepresented and underserved colleges and universities to compete for and conduct basic or applied NASA-related research. (APG revised: grants reduced from 350 to 50 based on FY 2006 Appropriation.)	Yellow	NASA exceeded the number of institutions during FY 2006, but did not achieve the targeted number of grant awards.	NASA's FY 2007 budget includes funds necessary to achieve future goals.
Efficiency Measures: Education				
6ED12	Peer review and competitively award at least 80%, by budget, of research projects.	Red	NASA could not complete this performance measure due to Congressionally directed, site-specific projects which accounted for approximately 50% of the Education Program's appropriation.	NASA has briefed relevant Congressional committee staff regarding the impact of Congressional interest items. NASA's FY 2007 program plan will achieve the target of 80% competitive awards unless Congressionally directed appropriations exceed 20% of the budget.

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Efficiency Measures: Earth–Sun System				
6ESS24	Complete all development projects within 110% of the cost and schedule baseline.	Red	The STEREO and AIM missions, scheduled for completion in FY 2006, exceeded 110% of the cost and schedule baselines. After launch vehicle delays, STEREO was launched on October 25, 2006, exceeding the baseline schedule by 25%. The final cost exceeded the baseline by 26%. AIM is currently scheduled for launch in spring 2007 and is expected to exceed both the cost and schedule baselines by approximately 20% due to delays associated with the launch vehicle and the failure of the SOFIE instrument during observatory vibration testing.	NASA will continue to conduct appropriate reviews as the AIM mission progresses toward launch.
Efficiency Measures: Solar System Exploration				
6SSE29	Complete all development projects within 110% of the cost and schedule baseline.	Red	The New Horizon and Dawn missions, scheduled for completion in FY 2006, exceeded 110% of the cost baseline. New Horizons, which was launched on time—January 19, 2006—exceeded the cost baseline by 15%. The Dawn mission, which underwent reviews to address technical and cost issues, is expected to exceed the cost baseline by 32% and the schedule baseline by 43% with the launch being delayed to 2007.	NASA will continue to conduct appropriate reviews as the Dawn mission progresses toward launch.
Efficiency Measures: The Universe				
6UNIV22	Complete all development projects within 110% of the cost and schedule baseline.	White	NASA did not schedule development projects related to this APG for completion in FY 2006.	N/A
6UNIV25	Reduce time within which 80% of NRA research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.	Yellow	NASA reduced the time necessary to award 80% of NRA grants by 2.5% from FY 2005 to FY 2006, missing the 5% target.	The Science Mission Directorate will continue to make efforts to reduce processing times and expects to meet this APG assuming no changes in procurement requirements or funding calendar.
Efficiency Measures: Exploration Systems Research and Technology				
6ESRT13	Complete all development projects within 110% of the cost and schedule baseline.	White	The technology priorities identified by the exploration architecture prompted restructuring of the technology program.	N/A

Performance Measure	Description	Rating	Why the Measure Was Not Met or Was Canceled	Plans for Achieving the Measure (If Not Canceled)
Efficiency Measures: Exploration Systems Research and Technology (Continued)				
6ESRT14	Peer review and competitively award at least 80%, by budget, of research projects.	White	The Exploration Technology Development Program (ETDP) did not issue any competitive solicitations this year for new research projects as a result of significant restructuring as mandated by ESAS. In the future, ETDP may use competitive solicitations where appropriate to address the priorities for lunar exploration.	N/A
6ESRT15	Reduce annually, the time to award competed projects, from proposal receipt to selection.	White	The ETDP did not issue any competitive solicitations this year for new research projects as a result of significant restructuring as mandated by ESAS. In the future, ETDP may use competitive solicitations where appropriate to address the priorities for lunar exploration.	N/A
6PROM4	Complete all development projects within 110% of the cost and schedule baseline.	White	This APG pertains to the conceptual design of a Nuclear Electric Propulsion (NEP) reactor. NASA has canceled the NEP project and all associated activities.	N/A
6PROM5	Reduce annually, the time to award competed projects, from proposal receipt to selection.	White	This APG pertains to the conceptual design of an NEP reactor. NASA has canceled the NEP project and all associated activities.	N/A
Efficiency Measures: Human Systems Research and Technology				
6HSRT22	Increase annually, the percentage of grants awarded on a competitive basis.	White	In October 2005 NASA instituted the Human Research Program (HRP) as a successor to the Human System Research and Technology (HSRT) program. HRP has focused on directed research tasks, as approved in the Program Management Plan (document number HRP-47051) to effectively use available funding and other resources. Therefore, this APG is no longer considered applicable by management directive.	N/A
Efficiency Measures: Space Flight Support				
6SFS7	Complete all development projects within 110% of the cost and schedule baseline.	White	There are no developmental programs in this organization.	N/A
Efficiency Measures: Space Shuttle				
6SSP2	Complete all development projects within 110% of the cost and schedule baseline.	White	NASA will retire the Space Shuttle once its role in International Space Station assembly is complete, by 2010. NASA does not plan to implement any additional major modifications to the Space Shuttle system before retirement.	N/A