NASA **Performance Report**

FISCAL YEAR 2000

MESSAGE FROM THE ADMINISTRATOR

NASA has much of which to be proud as we reflect on Fiscal Year 2000 performance. Challenges were formidable, but our resolve was equally intense. NASA seeks revolutionary breakthroughs in science and technology. In the laboratories, out in the field and aboard our spacecraft, dedicated men and women are working to expand the frontiers in air and space and benefit the quality of life on Earth. NASA's past, present, and future success is in large part due to the outstanding performance of our civil service and contractor workforce.

I thank the NASA Advisory Council (NAC) for its independent evaluation of NASA's performance. The NAC's review of NASA's reported performance is an important measure of our progress in achieving technological and scientific achievement. NAC recommendations regarding past performance have been used to further develop performance metrics that are provided in our Performance Plans. I would also like to thank the Office of the Inspector General for its evaluation of the validity of selected performance metrics. The results of both of these independent evaluations have been incorporated into this report.

While measuring performance in achieving program progress is an everyday task within NASA, the Government Performance and Results Act (GPRA) has provided NASA with a new performance measure, in which the perspective is external to the Agency. NASA appreciates the heightened level of accountability that GPRA affords. However, similar to the findings of the National Academy of Science, we have found that some of the specifics and expectations related to the implementation of GPRA performance measurement does not fully portray an appropriate performance assessment of scientific research, technology and development activities. NASA is formulating several recommendations it believes will help provide a more effective perspective on scientific research, technology and development program performance resulting in enhanced accountability to our stakeholders and the Public.

This is NASA's second opportunity to report performance within the GPRA process. Through this process we have learned a great deal. Each year, we believe we make further progress in better portraying our goals and commitments toward performance in terms that are relevant to the American people.

Daniel S. Goldin
Administrator

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Vision

NASA is an investment in America's future. As explorers, pioneers, and innovators, we boldly expand frontiers in air and space to inspire and serve America and to benefit the quality of life on Earth.

Mission

To advance and communicate scientific knowledge and understanding of Earth, the solar system, and the universe

To advance human exploration, use, and development of space

To research, develop, verify, and transfer advanced aeronautics, space, and related technologies

Introduction

Introduction

NASA's mission is to advance and communicate scientific knowledge and understanding of Earth, the solar system, and the universe; to advance human exploration, use, and development of space; and to research, develop, verify, and transfer advanced aeronautics, space, and related technologies.

In support of this mission, NASA has a strategic architecture that consists of four Enterprises supported by four Crosscutting Processes. The Strategic Enterprises are NASA's primary mission areas to include Earth Science, Space Science, Human Exploration and Development of Space, and Aerospace Technology. NASA's Crosscutting Processes are Manage Strategically, Provide Aerospace Products and Capabilities, Generate Knowledge, and Communicate Knowledge.

The implementation of NASA programs, science, and technology research occurs primarily at our Centers. NASA consists of a Headquarters, nine Centers, and the Jet Propulsion Laboratory, as well as several ancillary installations and offices in the United States and abroad. The nine Centers are as follows: 1) Ames Research Center (ARC), 2) Dryden Flight Research Center (DFRC), 3) Glenn Research Center (GRC), 4) Goddard Space Flight Center (GSFC), 5) Johnson Space

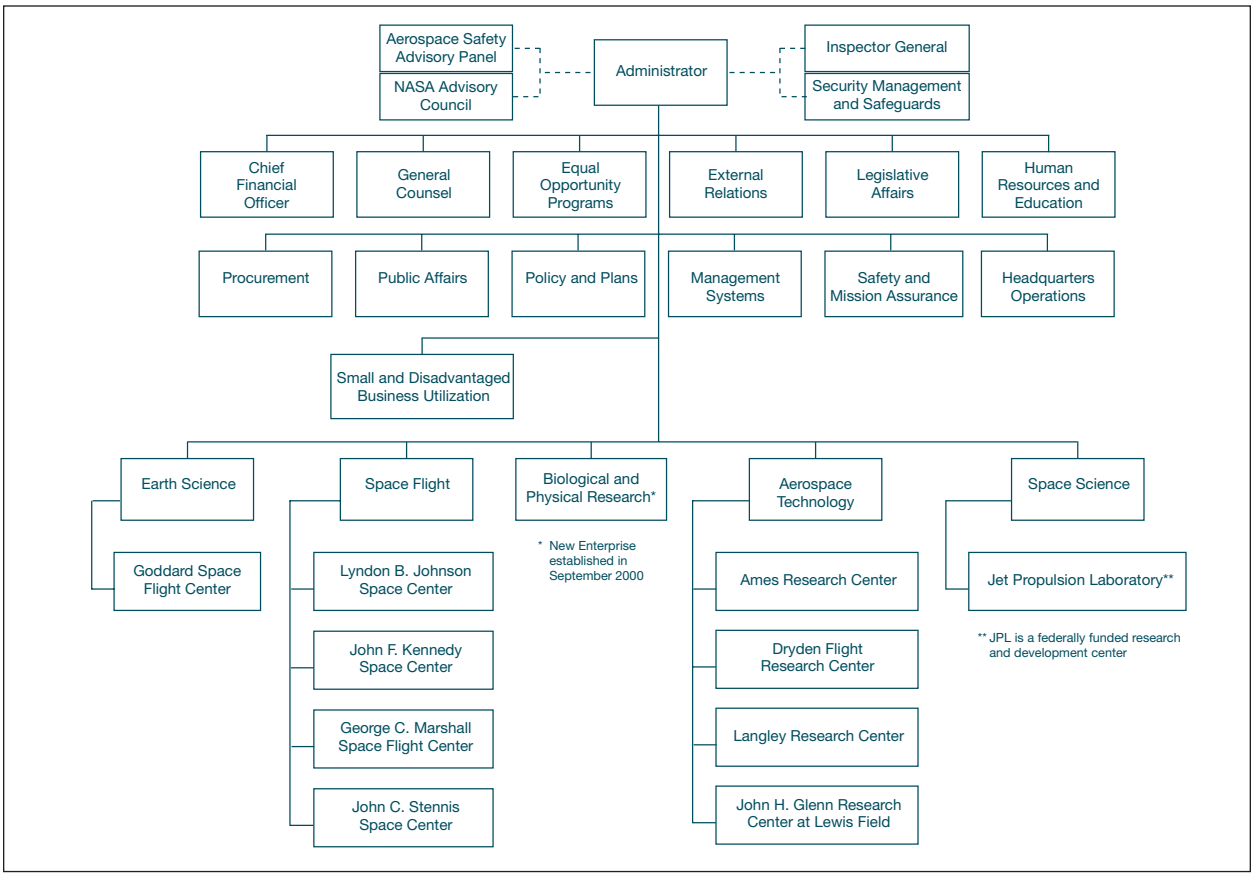


Figure 1. NASA Organization Chart

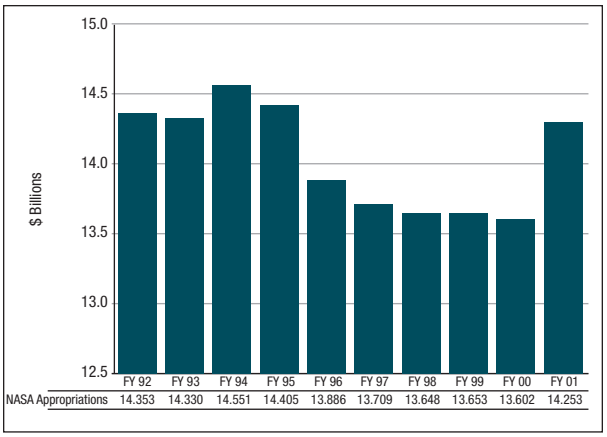


Figure 2. NASA Budget

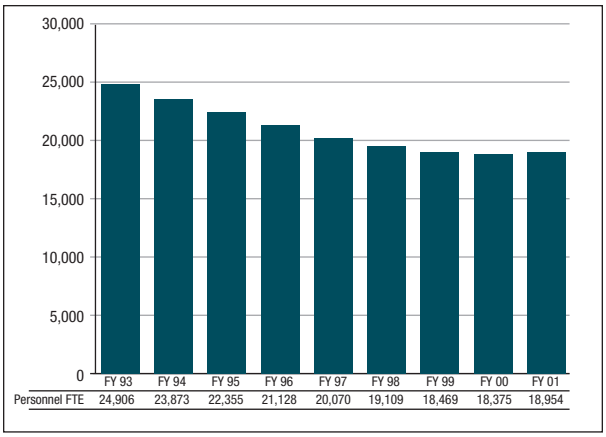


Figure 3. Personnel FTEs

Center (JSC), 6) Kennedy Space Center (KSC), 7) Langley Research Center (LaRC), 8) Marshall Space Flight Center (MSFC), and 9) Stennis Space Center (SSC).

Background

NASA is a Federal research and engineering Agency that accomplishes most of its space, aeronautics, science, and technology programs through nine Field Centers and the Jet Propulsion Laboratory, which is a federally funded research and development center (Figure 1). In Fiscal Year (FY) 2000, NASA received budget authority (New Obligations Authority, or NOA) of approximately $13.602 million (Figure 2) and maintained a civil service workforce of 18,375 full-time equivalents, or FTEs, including the Office of the Inspector General (OIG). (Figure 3).

NASA's program and support activities are guided by a strategic planning process and strategic management systems that are documented in the NASA Strategic Management Handbook, NASA Procedures and Guidelines (NPG) 1000.2. NASA's vision and mission statements have been extracted from our Strategic Plan and are provided on page 4.

NASA's Approach to Performance Measurement

At NASA, performance measurement is extremely useful in defining our goals, demonstrating our commitment to reaching our objectives, and in making management decisions. Performance measurement is also used to help guide research and development (R&D) activities that explore the frontiers of space, science, and technology. One of our most significant challenges is to implement an annual performance measurement under the Government Performance and Results Act (GPRA) that fully portrays an appropriate performance assessment in a research and development environment. As R&D outcomes are frequently not realized for years or perhaps decades, NASA believes that it is important to communicate annual progress towards achievement of those goals to our stakeholders, so that they might understand the relationship of current investments to the realization of those longer-term goals. NASA does not rely solely on output measures to show progress or demonstrate a contribution to intended results. However, developing annual outcome-oriented metrics for multi-year R&D programs is particularly challenging as these program metrics are "output" in nature since the program may not be mature enough to deliver "outcome" results for several years. The stated objectives of programs within NASA's Enterprises are long-term in character. For example, a deep space explorer would take multiple years to build and as much as another year to travel to its destination. During this period of three to five years, the project would need to be monitored by output metrics, until it was launched and reached the planet of study. Once the planet was reached, the data produced would yield the research outcomes specified in the original program's objectives. It is our goal to provide the most effective perspective on R&D program performance possible through the GPRA performance assessment process to the public and our stakeholders. NASA will continue to strive to meet the challenge of developing science and technology metrics that are outcome-oriented and useful in demonstrating how these outcomes benefit the public.

Report Organization

This report is organized in sections by Enterprise or Crosscutting Process and adheres to the following format:

Each section includes an introduction that discusses mission, as appropriate, and a summary of FY 2000 achievements towards meeting strategic goals and objectives. The reporting format is as follows:

Goal: As prescribed in NASA's Strategic Plan 1998 (as revised in 1999).

Objective: As prescribed in NASA's Strategic Plan 1998 (as revised in 1999).

Performance Target: Annual level of projected performance as prescribed in NASA's FY 2000 Performance Plan.

Actual Performance: Compares actual performance against performance projected in the FY 2000 Performance Plan.

Target Assessment: Provides a color assessment that summarizes performance.

The color key is:

Blue: Significantly exceeded targeted performance.

Green: Achieved targeted performance.

Yellow: Did not achieve performance target, although progress was significant and achievement is anticipated within the next fiscal year.

Red: Failed to achieve performance target, do not anticipate completion within the next fiscal year.

Data Sources: Provides data sources in support of reported achievement.

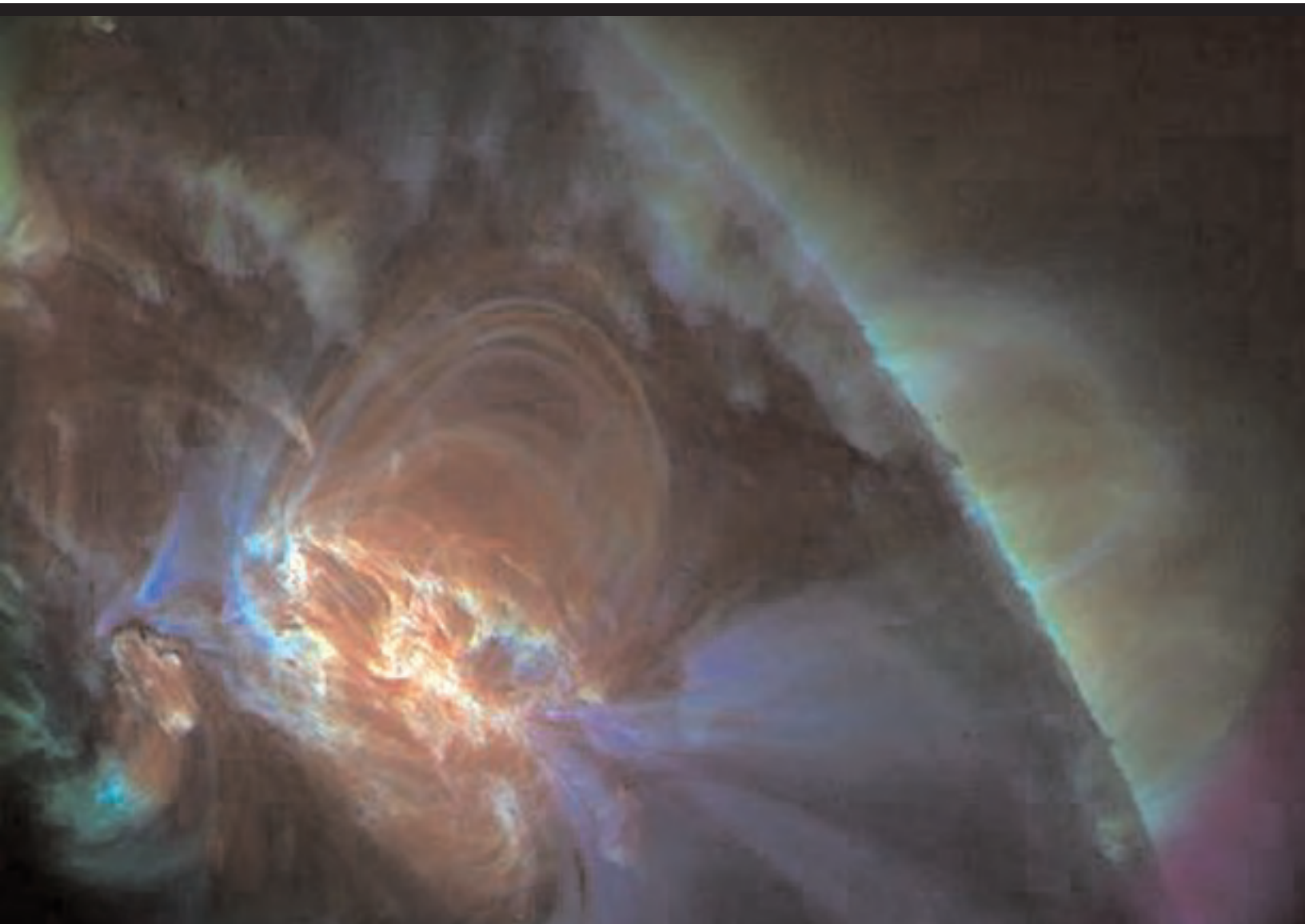
Verification/Validation: Provides method/approaches used to validate performance results.

NASA has incorporated new features in the FY 2000 Performance Report to clearly communicate performance and provide a balanced portrayal of achievements and disappointments. For example, the highly technical nature of a research and technology environment lends itself to complex narrative. NASA is working to portray performance in a way that is more easily appreciated by the public and our stakeholders. This report also includes statements explaining why the results are meaningful. To more effectively communicate our performance, NASA has included a color assessment for each target. These assessments are provided to help evaluate performance as reported. The FY 2000 report also includes verification/validation methods and data sources for each target to ensure that reported performance information is valid and reliable.

Trend charts are included at the end of each Enterprise and Crosscutting Process section. These charts provide a trend assessment when an FY 2000 target has a corresponding FY 1999 target. All FY 1999 and FY 2000 targets are displayed. Color assessments are included for each target to facilitate comparison. In many cases, NASA has developed new targets in response to program changes or as a result of experience gained in the performance planning process. In instances where a target was completed in FY 1999 or eliminated based on additional information or experience, the phrase "Target eliminated" or "No longer applicable" appears in the target assessment column. Newly developed targets that have no corresponding FY 1999 target to facilitate an assessment will be denoted by "New target."

Through the use of an improved reporting format (verification/validation methods and data sources for each target), statements of public benefit, and the addition of color target assessments and trend assessments, we hope to more effectively communicate and link our goals to issues that are meaningful to the public, engaging them in America's investment in the future.

NASA Advisory Council Assessment of FY 2000 Performance



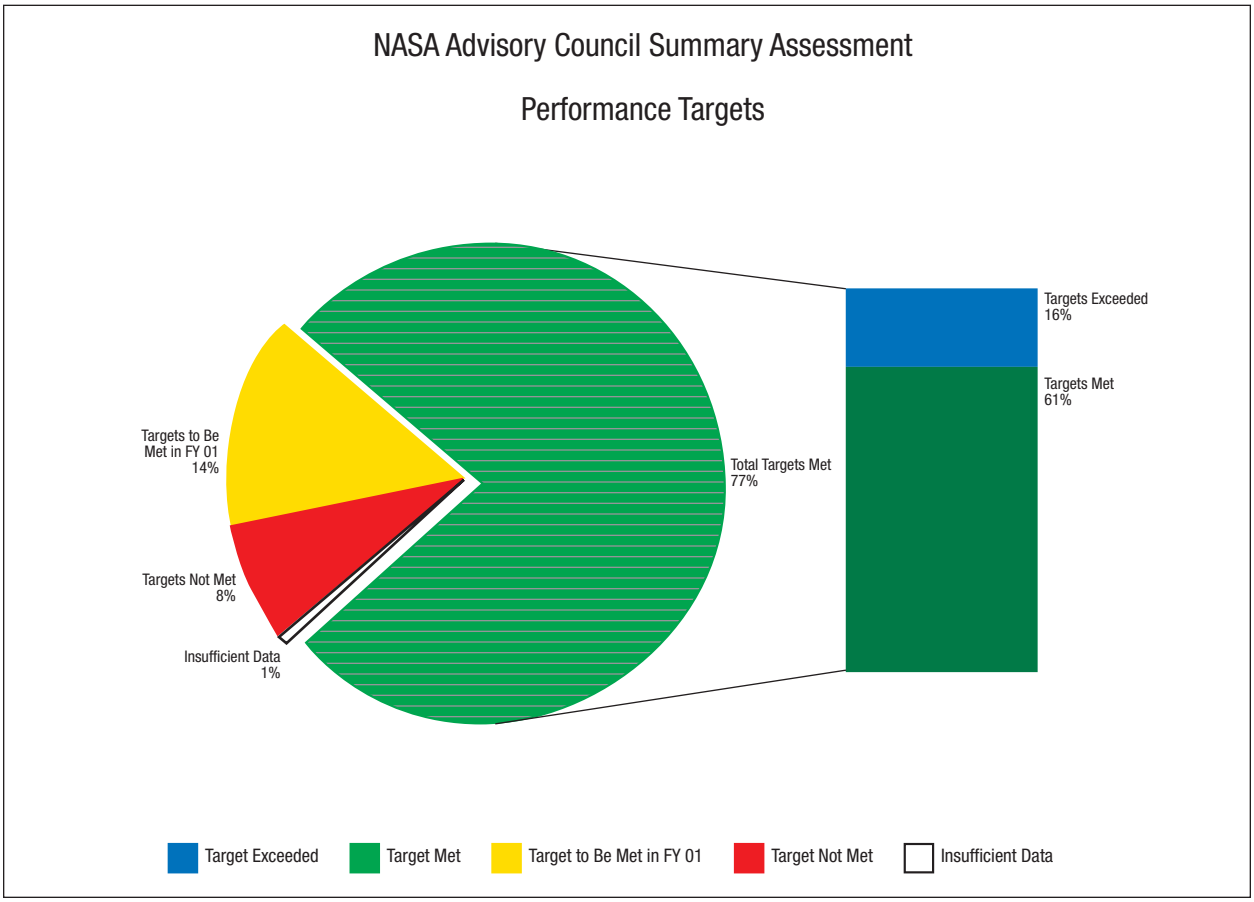
NASA Advisory Council

An important, continuing feature of our performance report is an independent assessment of NASA's performance by the NASA Advisory Council (NAC).

The overall purpose of the NAC is to provide an independent, expert forum to advise the Administrator on Agency programs, policies, plans, and other matters pertinent to NASA. NAC members are recognized experts in scientific, technological, and programmatic fields relevant to aeronautics and space. The NAC reports findings and recommendations directly to NASA's Administrator.

Since 1999, NASA has requested that its senior advisory body, the NAC, independently review NASA's annual performance results. The NAC reviewed each metric and provided a qualitative assessment of the Agency's progress. Enterprise Advisory Committees also reviewed performance prior to the NAC's review. NASA is committed to obtaining independent evaluations of our progress each year as a means of continuous improvement in metric development and performance reporting. Comments by the NAC are incorporated into future metric development efforts portrayed in Agency Performance Plans.

The NAC found that NASA successfully achieved most of its performance metrics for FY 2000. While the Agency did underperform in a few areas, many of these problems were associated with the loss of the Mars Polar Lander spacecraft, delays in the highly complex X-33 and X-34 programs, and a few delays in deploying the International Space Station due to problems with the Russian Proton rockets. All of these problems were associated with space exploration being a tough,



challenging endeavor and not something that easily fits into metrics or schedules. The NAC commended NASA for taking safety seriously and not unduly increasing risk to meet artificially set performance metrics or launch dates.

Highlights of the NAC's assessment included:

Aerospace Technology:

- All programs but one are generally well focused and are demonstrating good progress.
- Two significant accomplishments were in the environmental area.
- The most significant achievement was in space propulsion.
- Space transportation efforts failed to achieve objectives and milestone for X-33 and X-34.

Life and Microgravity Sciences and Applications (OLMSA):

Continues to make strong progress in its efforts to develop and maintain an outstanding pool of researchers for the ISS.

Space Science:

- Space Science made significant scientific discoveries.
- The one major failure was the Mars Polar Lander that failed to land on Mars.

Earth Science:

Earth Science had a very good year; there were no failures.

- Terra is working well and producing results.
- SRTM Shuttle mission has lived up to the expectation of mapping most of Earth's surface.

Space Shuttle and International Space Station (Office of Space Flight):

- Space Shuttle achieved 100 percent mission success.
- ISS had a productive year after the schedule slip caused by Russian Proton rocket failures.
- Area requiring attention is the Shuttle Safety Upgrades Program.

Agency Crosscutting Processes:

- Provide Aerospace Products and Capabilities (PAPAC) area needs targets that better relate to the objectives.
- Targets in "Generate Knowledge" and "Communicate Knowledge" need further clarification and definition.
- Agency failed to achieve the Integrated Financial Management Program goal; however, the Agency is on track to implement a new system.

February 16, 2001

Mr. Daniel S. Goldin
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Mr. Goldin,

The NASA Advisory Council spent most of its December 2000 meeting reviewing NASA's performance against its FY 2000 Performance Plan. As you know, the Agency requested the Council to independently review its annual Performance Plan as a part of NASA's submission to Congress for the Government Performance and Results Act (GPRA).

The Council found the Agency successfully achieved most of its performance metrics for FY 2000. NASA should be proud of this accomplishment. While the Agency did underperform in a few areas, many of these problems were associated with problems with the loss of the Mars Polar Lander spacecraft, delays in the highly complex X-33 and X-34 programs, and a few delays in deploying the International Space Station due to problems with the Russian Proton rockets. All of these problems were associated with space exploration being a tough, challenging endeavor and not something that easily fits into metrics or schedules.

Additionally, the Council believes the Agency should be commended for taking safety seriously and not unduly increasing risk to meet artificially set performance metrics or launch dates. Safety remains NASA's number one priority, and it is reflected in the Agency's FY 2000 performance.

The Council had a few general comments about the FY 2000 Performance Metrics. In many cases, we found that many performance targets (throughout all Enterprises) were simply too vague. The targets do not relate closely enough to the actual programs being implemented. Targets need to be better written and should tell the public why the metric or program is important. Every target needs to have a "person on the street" impact statement. Finally, the area in need of most improvement is the crosscutting metrics.

The Council looks forward to having input into the development of the FY 2002 and FY 2003 plans in an effort to improve the process as we move forward. We are pleased with the level of increased interaction between the Council and the Office of the Chief Financial Officer in formulating future performance targets. We look forward to being active participants in the Agency GPRA process.

Sincerely,

Bradford W. Parkinson
Chair, NASA Advisory Council

NASA Advisory Council (NAC) Assessment of FY 2000 Performance

The following comments are specific to each of the evaluation areas:

Earth Science

The Earth Science Enterprise had a very good year. First, the Enterprise has articulated and refined a very good Science Implementation Plan and is well advanced in the development of a similar plan for the new Applications and Outreach division. Second, the Enterprise has developed very successful technology and data/information activities. This has been a major improvement over the years. Third, the Nation now has an unparalleled Earth observation system that is working very well. During 1999 and 2000, ten successful launches and missions have occurred. Two highlights: Terra, launched at the end of 1999 (December 8, 1999) is working well and producing results; the Shuttle Radar Topography Mission (SRTM) has lived up to the expectation of mapping most of Earth's surface. Earlier missions like the Tropical Rainfall Measuring Mission (TRMM) and Landsat 7 are working at or beyond expectations. In fact, the life of the TRMM satellite may almost have doubled.

The Enterprise exceeded target performance for FY 2000 in eight areas related to data systems and architecture, data dissemination, and education/outreach. It achieved another 37 targets and had significant progress in 4. There were no failures. Failing to launch JASON-1, because of difficulties with the international partner, was the most significant underperformance.

The Enterprise and its advisory committee are working closely to develop improved measures of performance and targets that map to the increasingly well defined science and application objectives. New review processes are also being considered to increase participation of the community and the advisory board. These groups will help gauge performance and satisfaction with the Enterprise products.

Space Shuttle and International Space Station (Human Exploration and Development of Space [HEDS])

The two most important FY 2000 goals established for the Office of Space Flight (OSF) have been successfully and safely achieved, namely: 1) The Space Shuttle achieved 100 percent mission success; 2) The International Space Station (ISS) program has had a productive year after the schedule slip caused by the Russian Proton rocket failures.

The single area that needs focused attention is the Shuttle Safety Upgrades Program. The cost growth and lack of a stable program, even at this early stage, is cause for concern. Management needs to focus attention on this program until it is properly defined and proper cost estimates are developed.

In areas of conducting human missions of exploration, the objectives are large and complex long-term programmatic efforts. While OSF accomplished their performance targets in these areas, the targets were only small steps in larger Agency efforts.

Space Science

The Space Science Enterprise did a good job of meeting its performance targets in FY 2000, with significant scientific discoveries across the full spectrum of Code S activities. Results from the Balloon Observations of Millimetric Extragalactic Radiation and Geophysics (BOOMERANG) balloon-borne payload and other experiments provided strong evidence that the inflationary scenario of Big Bang cosmology is correct and that the expansion of the Universe may be accelerating. The Chandra orbital observatory provided a wealth of new observations of the universe at x-ray wavelengths. Unusually high levels of solar activity allowed a fleet of solar physics spacecraft to observe phenomena that provided new insights into the behavior of the Sun. The NEAR Shoemaker spacecraft provided the first comprehensive look at an asteroid, and the Mars Global Surveyor provided strong evidence for the presence of liquid water on the surface of Mars in both the distant and recent past.

There was one major failure in FY 2000. The Mars Polar Lander failed to land successfully on Mars, resulting in the complete loss of that mission. This loss, coupled with the loss of the Mars Climate Orbiter in FY 1999, brought about a major restructuring of the NASA Mars Exploration Program. While these changes have been difficult, they have strengthened the program significantly, increasing the prospects for achieving success in the future. In its overall performance, the Space Science Enterprise clearly met a tough set of expectations in FY 2000.

Aerospace Technology

The Office of Aerospace Technology (OAT) programs remain generally well focused and, with one exception, are demonstrating good progress. Air traffic, safety, and environmental work are enhanced by a planned synergy of complementary work with the Federal Aviation Administration (FAA). Infrastructure efforts to integrate and enhance design, development, and technology tools in a distributed environment remain on track, showing good progress. Likewise, elements of OAT's "outreach" programs, including technology transfer initiatives, have demonstrated excellent progress. Efforts to improve ground operations (incursion avoidance) and increase throughput are an excellent start to achieve near-term goals, but much effort remains to accomplish overall objectives.

Two of the more significant accomplishments are in the environmental area, with noise and emissions reductions that either met or significantly exceeded performance targets. Significant progress was made to improve turbine engine performance for General Aviation, although flight demonstration was replanned to coincide with new aircraft development by the manufacturers. Equivalent piston engine progress is lagging behind plan. Progress toward experimental aircraft goals was achieved, but Environmental Research Aircraft and Sensor Technology (ERAST) performance targets were redefined and the X-43 flight test schedule was replanned.

The Advisory Council notes that the most significant achievement may have been in space propulsion. Demonstration of a complete NASA Solar Electric Propulsion Technology Application Readiness (NSTAR) mission profile to achieve 100 percent design life (10,375 hours of operation) for Deep Space 1 now establishes ion propulsion as a legitimate option for deep space solar system exploration missions.

On the down side, space transportation efforts have failed to achieve the objectives and milestones planned for X-33 and X-34. The Advisory Council notes that new initiatives have begun as an outgrowth of the integrated space transportation architecture studies, recognizing the failure to achieve technology readiness for single stage to orbit. However, the Council finds focused program efforts for a new Space Launch Initiative to be elusive at best. This again highlights the time-lapse between definition and evaluation of specific (and critical) performance targets.

Life and Microgravity Sciences and Applications

The Office of Life and Microgravity Sciences and Applications (OLMSA) continues to make strong progress in its efforts to develop and maintain an outstanding pool of

researchers for the International Space Station.

OLMSA made awards under 6 NASA Research Announcements (NRAs) in FY 2000 and built its investigator community to approximately 960 investigations as part of continuing preparations for ISS utilization. OLMSA completed preparations for research on STS-107, currently scheduled for launch at the end of FY 2001, and completed data reduction activities for the successful flight of STS-95. OLMSA executed a new memorandum of understanding with the National Cancer Institute focusing on new approaches to detect, monitor, and treat disease. This cutting-edge effort uses biological models to develop medical sensors that will be smaller, more sensitive, and more specific than today's state of the art. The Office established a pricing policy for Commercial Demonstration program on the International Space Station and entered into two initial commercial agreements.

OLMSA has successfully met all of its performance targets except one. The exception involved schedule slips and a technical failure for sounding rocket experiments. While the committee recognizes the challenges inherent in developing targets for a research organization such as OLMSA, we remain concerned that OLMSA performance targets do not effectively measure progress toward OLMSA's broader goals and objectives. Given the current level of resources available to OLMSA, progress toward attainment of the goals of understanding microgravity, preparing for long-term flight, and fostering commercialization will be slow.

Agency Crosscutting Processes

The Agency achieved most of its FY 2000 Performance Plan objectives in its Crosscutting Processes. However, the Council is concerned that many of the targets under the four crosscutting processes are not adequately defined to measure whether their objectives are achieved. Many of the targets in the "Communicate Knowledge" and "Generate Knowledge" areas need further clarification and definition. Additionally, the "Provide Aerospace Products and Capabilities" area needs targets which better relate to the objective.

Last year, an area of major concern was the lack of progress in implementation and validation of the Agency's new Integrated Financial Management Program (IFMP). The Council downgraded the Agency self-assessment in this area. The Agency has failed to achieve the schedule goal for FY 2000. However, the Agency has stepped forward to add management attention and resources to revamp the effort. While missing the FY 2000 goal, the Agency seems to be on track to implement a new system in the coming years.

Assessment Color Key

Blue: Significantly exceeded performance target.
Green: Achieved performance target.
Yellow: Did not achieve performance target, progress was significant and achievement is anticipated within next fiscal year.
Red: Failed to achieve performance target, do not anticipate completion with next fiscal year, target may be infeasible or non-achievable.
White: Insufficient data to determine assessment.

NASA's Summary of FY 2000 Performance

The year 2000 was a year of great achievement for NASA. Scientists, using data from the Mars Global Surveyor, found evidence suggesting sources of water on Mars. Progress on the International Space Station (ISS) paved the way for the arrival of ISS's first international research team and the beginning of a new era in international space research cooperation. Improvements in Earth remote-sensing data and analysis continued to build our capability to understand and predict the behavior of our planet. In aerospace research, breakthroughs included development of a turbulence prediction system that will save lives by enabling aircraft to land more safely.

But while NASA has much of which to be proud in its performance over the past year, there were also disappointments, most notably in the Mars missions and X-33 and X-34 development. In terms of the GPRA scorecard, NASA set an extremely challenging complement of targets. Many of the targets, particularly in the case of flight projects, were literally on the cutting edge of scientific and technical capability. NASA was unable to achieve all of them. Yet, this is the level of difficulty at which NASA needs to operate to achieve the type of advances that are at the heart of the NASA mission. It is in the very nature of exploration and research and development to feature unpredictable timeframes and even unforeseeable results. The Agency consciously decided not to choose easily achievable performance targets. Instead, NASA has historically declared its intention to accomplish something that not only has never been done before but that is not even the next small step in a predictable, incremental process. NASA is still in the business of "giant leaps."

Thus, as much as in NASA's successes, it is through its failures that the Agency has advanced the state of the art of science and technology. The Mars experience gave rise to review panels that analyzed how NASA can do a better job and reduce the chance of future error. NASA is now in the process of implementing these recommendations to ensure more effective technology development and the most efficient management processes. Similarly, during FY 2000, NASA redefined some initial targets based on better subsequent judgment or information. The result is frequently a better outcome, often including knowledge gained that ultimately advances the mission. For example, NASA ambitiously set a tough target for ontime successful Space Shuttle launches, but upon conscientious examination of the risks, Senior Management concluded that the indicator might compromise safety—an unacceptable effect. NASA decided to abandon the pursuit of the targeted performance rather than possibly risk the safety of the astronauts. With regard to performance reporting, the target was reported as "no longer applicable." However, every mission success begins with safety, and that was certainly accomplished. In some targets not achieved, scientists and engineers were able to identify which aspect of the effort was not working, solve the problem, and set a revised, more feasible target date, based on the knowledge gained in the initial attempt.

For NASA, the GPRA performance process entails a significant challenge to set annual performance goals (targets) that stretch beyond the bounds of foreseeable achievement, a hallmark of NASA's success. But NASA welcomes the process. GPRA's visible, specific milestones contribute additional rigor to NASA's already intensely dedicated and determined effort. NASA looks forward to building on all that we have achieved and learned in this first year of the millennium, to continue to expand the frontiers of flight, space, and knowledge, and improve life on Earth.

NASA's Verification and Validation of Performance Data

NASA is committed to ensuring that reported performance information is valid and reliable. Data credibility is a critical element in the Agency's ability to manage results and to be accountable for the accuracy of performance data. NASA's performance in developing and delivering products and services is evaluated at the Agency, Strategic Enterprise, Functional Office, program and project, Crosscutting Process, and individual levels. Each level has the responsibility to execute requirements and to measure, evaluate, and report results. Methods and procedures for collecting this information are evaluated and validated by program managers who are responsible for data collection and reporting. As each part of the organization completes its measurement process, data are used to validate that performance meets or exceeds planned goals, objectives, and performance targets. In those situations in which performance does not meet expectations, opportunities for continuous improvement are identified.

Communicating our verification and validation approaches provides greater confidence that reported performance information is credible while enhancing the usefulness of the information. In FY 2000, NASA provided specific documentation of achievement by providing verification and validation methods and data sources for each target. Data sources that were used included, but were not limited to, databases used for other purposes, third-party reviews, and certification by managers and/or contractors. Changes or improvements to existing data collection and reporting systems or processes were included in the verification methodology. As appropriate, reliance upon external sources were identified in the data sources section of each target's performance. With regard to external data sources, NASA relies on the individuals responsible for the performance to validate and verify the information provided for GPRA compliance.

For the purpose of assessing NASA's overall performance, we will continue to ask our Advisory Committees to evaluate accomplishments at the Enterprise level. Their assessments not only integrate quantitative output measures but also provide balance in the context of safety, quality, high performance, and appropriate risk. The NASA Advisory Council evaluates annual performance for both the Enterprises and the Crosscutting Processes, assessing both actual performance and progress towards strategic goal and objective achievement. Their independent assessment of NASA's performance is highlighted in this report. In addition, the Office of the Inspector General (OIG) has conducted validation audits of reported performance data used to support the Agency's actual results on selected performance targets to ensure that underlying performance data are accurate and reliable. The OIG commended NASA in their audit of the FY 2000 performance data for the significant improvement in the reporting of actual performance.

Earth Science Enterprise

FY 2000 Earth Science Enterprise

In the realm of science, 2000 was another year of substantial accomplishment toward understanding the Earth system. During an 11-day Space Shuttle mission, a new inteferometric synthetic aperture radar technique collected data sufficient to produce the first detailed topographic map of the entire land surface of Earth between 60°N and 56°S. Landsat 7 completed a global survey of Earth's land cover, and the Terra satellite observed the global land and ocean biosphere as it undergoes seasonal changes and showed that snow cover over North America was substantially below normal following the warmest winter on record. The QuikSCAT satellite observes on a daily basis the formation and dissipation of storms and hurricanes under all weather conditions, and this information is now being used routinely by the National Oceanic and Atmospheric Administration (NOAA) for improving forecasts of these events.

The United States and Canada mapped Antarctica for the second time with space-based radar in order to compare observations with an earlier map to determine its change over time. Using data from the U.S./Japan Tropical Rainfall Measuring Mission, researchers determined that the types and origins of suspended particles in the atmosphere, which serve as a nucleus for raindrops, affect intensity of rainfall downwind of their sources. Also in 2000, the Earth Science Enterprise (ESE) formulated a new research strategy for 2000-2010 to guide NASA research over the next decade, identifying 23 strategically important scientific questions to the Nation in the Earth system paradigm of variability, forcing, response, consequence, and prediction. This research strategy will guide ESE's science activities and investments in support of national priorities over the next decade.

In the area of applications, ESE has entered into a variety of partnerships that will actually produce the goods and services made possible by ESE's research and technology. ESE provides QuikSCAT data in real time to NOAA to improve marine weather forecasting and has used these data to show that severe storms forming over the oceans and approaching land can be predicted as much as two days in advance. ESE is working with the Federal Emergency Management Agency (FEMA) to use remote sensing tools to update its flood plain maps in a cost-effective way throughout the United States. In a partnership called AG 2020 with the United States Department of Agriculture (USDA) and four growers' associations representing over 100,000 farmers, ESE is helping to demonstrate how to improve crop productivity, reduce risks to crop health, and manage environmental impacts. With the National Institutes of Health (NIH), NASA is exploring the use of satellite data to project the spread of infectious diseases that are highly influenced by weather and climate, such as malaria. Throughout the summer, three ESE satellites tracked devastating wildfires in the western United States, providing data to the U.S. Forest Service and regional authorities. This information and management decision tool is now being adopted and used routinely by the Forest Service in the western United States. ESE held three regional workshops across the United States to identify and plan the next generation of

applications demonstration projects with State and local governments.

In the development of advanced technology, ESE completed preparation for the launch of its first New Millennium Program satellite to demonstrate a variety of new technologies for Earth Science. These include a new instrument that will produce Landsat-type sensor data from one-fourth the size of the current Landsat 7 instrument, and also for the first time a hyperspectral imager in space that views the land surface in more than 200 colors. NASA-sponsored technology research with universities, industry, and other Government laboratories moved 20 different remote-sensing instrument concepts one step closer to full maturity. These technologies will substantially reduce the cost and enhance the capability of new satellites over the next decade or more.

The ESE has had a string of six successful launches since the beginning of 1999. Combined with our ongoing research, these launches have served to make 2000 our most productive year yet. Even with development of the information processing and distribution system for Earth Observing System (EOS) spacecraft having only reached the 90 percent completion point, it is currently processing over a terabyte of data per day, and serviced 1.5 million user requests in 2000.

Goals

The ESE's mission is to understand the total Earth system and the effects of natural and human-induced changes on the global environment. The goals are as follows:

- Disseminate information about the Earth system
- Expand scientific knowledge of the Earth system using NASA's unique vantage points of space, aircraft, and in situ platforms, creating an international capability to forecast and assess the health of the Earth system
- Enable the productive use of Earth science technology in the public and private sectors

Programs of the Enterprise advance the new discipline of Earth system science, with a near-term emphasis on climate change.

Performance Measures

Forty out of 46, or 87 percent, of the targets were fully achieved. One of the remaining targets was deferred to FY 2001, due to circumstances beyond NASA's control, i.e., the launch delay of the Jason satellite due to lack of readiness by our international partner. We have made significant progress towards achieving the remaining five targets and anticipate their full achievement in FY 2001. One of the five is waiting on science quality satellite data from a new, onorbit sensor. One was not achieved due to a change in program emphasis that resulted in an improvement in the program but a delay in achieving the target. The remaining three, deferred to FY 2001, needed additional time to complete.

Goal: Expand scientific knowledge of the Earth system using NASA's unique vantage points of space, aircraft, and in situ platforms, creating an international capability to forecast and assess the health of the Earth system.

Objective: Understand the causes and consequences of land cover/land use change.

Performance Target: Continue the development of a global land cover/use change data set based on Landsat and EOS instruments, at seasonal refresh rate. **FY 2000 Earth Science #1 (0Y1)**

In order to understand the nature of changes in Earth's surface, we must monitor, on a regular basis, how natural and human-induced change affects Earth's vegetation cover.

Actual Performance: Landsat 7 is acquiring global data with seasonal refresh, providing an unprecedented data set for global land cover and land use mapping. The land use and land cover program is utilizing these data to undertake regional scale land cover and land use studies. Regional land cover mapping and land use studies are being undertaken in the United States and abroad. Examples include the Midwest United States; the Owens Valley, California; the Yucatan Peninsula, Mexico; the Brazilian Amazon; and Southern Africa. Also, a global land cover map generated from Advanced Very High-Resolution Radiometer (AVHRR) data has been validated by the use of Landsat data. The Moderate Resolution

Imaging Spectroradiometer (MODIS) is collecting data on a daily basis and applying algorithms to provide land cover characterization and land cover change products.

Target Assessment: Green

Data Sources: Data are available at the following Web sites:
AVHRR global land cover map: *http://lcluc.gsfc.nasa.gov/products/SignificantResults/index.asp*
Level 1 MODIS data: *http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/MODIS/products.shtml*
Land Products: *http://edcdaac.usgs.gov/dataproducts.html*

Verification/Validation: The NASA Land Cover/Land Use discipline manager in the Office of Earth Science evaluates Landsat 7, AVHRR and MODIS data to ensure validity of the data set. The Web sites listed above contain global land cover/use change data.

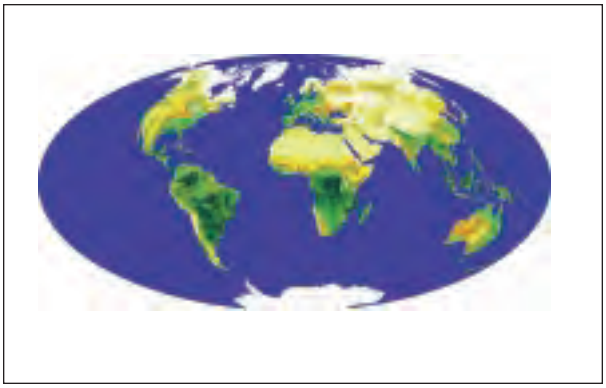
Performance Target: Continue to collect near-daily global measurements of the terrestrial biosphere (an index of terrestrial photosynthetic processes from which calculations of carbon uptake are made) from instruments on the Terra spacecraft. **FY 2000 Earth Science #2 (0Y2)**

A key component to NASA's ESE research effort is the monitoring of Earth's biosphere—a key indicator of the health of our planet.

Actual performance: The Terra spacecraft was launched in December 1999. Its instruments were activated for science operations on February 24, 2000, and are operating well. Calibration and validation activities are underway, and the data quality from all Terra sensors appears to be exceptional.

Near-daily global measurements (Level 0 data) of the terrestrial biosphere have been collected by the MODIS instrument and archived since February 24, 2000. Data have been processed and are available from March 18, 2000 onward. Overlap with the AVHRR sensor, to establish continuity of the data from the prior decades to the present data to document changes, to that from Terra's MODIS sensor, was achieved.

Target Assessment: Green



Global vegetation index map acquired by MODIS instrument.

Data Sources: The following Web sites contain the MODIS data.
http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/MODIS/data_access.shtml
http://redhook.gsfc.nasa.gov/~imswww/pub/imswelcome/

Verification/Validation: The MODIS global Level 0, 1A, and 1B data are physically archived at Goddard Space Flight Center (GSFC) Distributed Active Archive Center (DAAC). The NASA Terrestrial Ecology discipline manager has verified the required data products as listed in the actual performance section.

Performance Target: Continue the ocean color time series with 60 percent global coverage every 4 days—a 35 percent improvement over FY 1999. **FY 2000 Earth Science #3 (0Y3)**

Monitoring the color of the world's oceans from space gives Earth Science researchers valuable information about how life within the seas, and the global carbon cycle, are behaving.

Actual Performance: The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) satellite now acquires nearly 100 percent of the visible portion of the Earth every 2 days.

Target Assessment: Green

Data Source: The GSFC DAAC received approximately 1.6 TB of data Global Air Coverage (GAC) and Land Air Coverage (LAC) this year.

Verification/Validation: The two-day coverage is required to account for the losses due to the tilt maneuver of the sensor and

interorbit gaps. When clouds are taken into consideration, the coverage is reduced to 50–60 percent. The SeaWiFS Project has increased the Global Area Coverage data beyond that expected by eight percent by collecting data to higher latitudes than planned on all orbits. However, pole-to-pole coverage each day is not possible since data at low Sun angles are not scientifically useful for ocean color research. The MODIS instrument aboard Terra is beginning to supply additional data to meet the ocean color requirement.

Performance Target: Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies (SIMBIOS) will merge MODIS ocean color data into global ocean color time series, which began with Ocean Color Temperature Sensor (OCTS) and SeaWiFS. NASA will use the time series to understand and predict the response of the marine ecosystem to climate change, and will make the data set available via the GSFC DAAC. **FY 2000 Earth Science #4 (0Y4)**

Combining data sets from various Earth-observing instruments can provide new insights into important oceanography questions.

Actual Performance: A SIMBIOS Principal Investigator combined Preliminary MODIS data with SeaWiFS data. These results were encouraging but, due to a lack of science quality MODIS ocean color data, the project has been delayed. Combined data set availability in the DAAC is dependent on the availability of valid MODIS data.

Target Assessment: Yellow—Did not fully achieve this performance target, but progress was significant and achievement is anticipated within the next year.

Data Source: Preliminary results are held by the SIMBIOS Principal Investigator.

Verification/Validation: The Ocean Biogeochemistry discipline manager has evaluated progress with the SIMBIOS Principal Investigator. The method being used requires a truth field, which has been chosen as SeaWiFS for the time being. Then MODIS data are blended into the truth field so as to retain its spatial variability, but its magnitude is adjusted to SeaWiFS. The blended result contains all SeaWiFS data where SeaWiFS exists, and MODIS data adjusted to the SeaWiFS magnitudes where SeaWiFS does not exist. In the Southern Hemisphere, where there is a lack of SeaWiFS data, the data set requires further improvement. The initial assessment is that the blend looks very similar to an extended SeaWiFS data set. The SIMBIOS Project has completed a cross-calibration of the Advanced Earth Observation Satellite (ADEOS-1), OCTS and Polarization and Directionality of Earth's Reflectance (POLDER) instruments in collaboration with Japan and France. Also, the MODIS Oceans Team will deliver new processing software in November which should improve data quality to a level sufficient for an initial merging of SeaWiFS and MODIS oceans products.

Performance Target: Produce near real-time fire monitoring and impact assessment, based on Landsat and EOS inventory and process monitoring to provide an observational foundation for monitoring change in ecosystem productivity and disturbance. Post near real-time assessments on a Web site for quick access by researchers and regional authorities. **FY 2000 Earth Science #7 (0Y7)**

Observing wildfires from space provides emergency workers on Earth insights into ways to best combat these costly and deadly phenomena. NASA, in partnering with other Federal agencies, provides imagery that is not only scientifically significant, but also vital for effective response to these destructive events.

Actual Performance: During the recent fire season, data from Landsat and Terra was made available to the U.S. Forest Service for the Montana wildfires. It also was done for the South African Fire-Atmospheric Research Initiative (SAFARI) using AVHRR/SeaWiFS and Landsat. This work provides a basis for continued monitoring.

Target Assessment: Green

Data Sources: Fire monitoring products can be found at the following URLs:
http://earthobservatory.nasa.gov/Observatory/Datasets/fires.trmm.html
http://dante.gsfc.nasa.gov/safari/
http://earthobservatory.nasa.gov/Newsroom/NasaNews/2000/20000009124019.html

Verification/Validation: The MODIS Web site: *http://modland.nascom.nasa.gov/browse/* provides fire monitoring

products for post near real-time assessment. The MODIS Fire Team leader has authorized the information on the site.

Objective: Predict seasonal-to-interannual climate variations.

Performance Target: Establish a benchmark for global and regional rainfall measurements by combining Tropical Rainfall Measuring Mission (TRMM) measurements with measurements from other sources. Create maps of the diurnal cycle of precipitation for the first time. Combine the existing 10-year data set with TRMM measures to validate climate models and demonstrate the impact of rainfall on short-term weather forecasting. Distribute through the Goddard DAAC for ease of access to science and operational users. **FY 2000 Earth Science #9 (0Y9)**

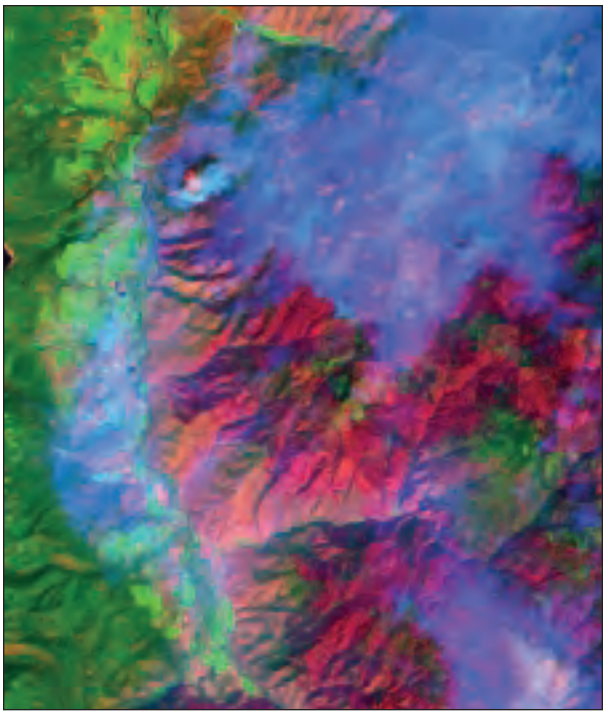
Understanding how rain falls around Earth is an important factor in the larger question of how water, vital to life on Earth, cycles through our planet's environment.

Actual Performance: Tropical rainfall estimates from TRMM have further converged (Kumarow et al.) and been combined with other satellite and surface-based measurements (Adler et al., 2000) to establish a standard for comparison with existing data sets and climatologies. The diurnal variation of precipitation over the oceans has been mapped with the first two years of TRMM data and shows a distinct early morning peak (manuscripts in preparation). The utility of precipitation information as input into numerical weather forecasting models for the improvement of weather forecasts, including improving hurricane forecasting, also has been shown using a combination of TRMM and other existing precipitation data. (Krishnamurti et al., 2000). TRMM data (41 terabytes[compressed]) were distributed by the GSFC DAAC to 220 users during the mission's lifetime up to this point.

Target Assessment: Green

Data Sources: Adler, R.F., G.J. Huffman, D.T. Bolvin, S. Curtis, E.J. Nelkin, 2000: "Tropical Rainfall Distributions Determined Using TRMM Combined with Other Satellite and Rain Gauge Information." *J. Appl. Meteor.* (accepted).

Kummerow, C., J. Simpson, O. Thiele, W. Barnes, A.T.C. Chang, E. Stocker, R.F. Adler, A. Hou, R. Kakar, F. Wentz, P. Ashcroft, T. Kozu, Y. Hong, K. Okamoto, T. Iguchi, H. Kuroiwa, I.Z. Haddad, G. Huffman, T. Krishnamurti, B. Ferrier, W.S. Olson, E. Zipser, E.A. Smith, T.T. Wilheit, G. North and K. Nakamura, 2000: "The Status of the Tropical Rainfall Measuring Mission (TRMM) After Two Years in Orbit." *J. Appl. Meteor.* (accepted).



Landsat 7 image of the Montana wildland fires acquired on August 14, 2000.

Krishnamurti, T.N., S. Surendran, D. Shin, R. Correa-Torres, T. Kumar, E. Williford, C. Kummerow, R. Adler, J. Simpson, R. Kakar, W. Olson, J. Turk, 2000: "Real-time Multi-analysis/Multi-model Super Ensemble Forecasts of Precipitation Using TRMM and SSM/I Products." *Mon. Wea. Rev.* (submitted).

Verification/Validation: The ESE TRMM discipline manager provided the above listed articles as evidence that the performance cited was published in scientific journals.

Performance Target: Develop and improve methods to couple state-of-the-art land surface and sea ice models to a global, coupled ocean-atmosphere model and use to predict regional climactic consequences of El Niño or La Niña occurrence in the tropical Pacific. Results of research

will be published in open literature and provided to the National Oceanic and Atmospheric Administration's (NOAA) National Climate Prediction Center and the U.S. Navy's Fleet Numeric Prediction Center. The ultimate goal is to develop a capability to significantly improve prediction of seasonal-to-interannual climate variations and their regional climate consequences. The main focus is on North America. **FY 2000 Earth Science #10 (0Y10)**

Ice around the globe provides a long-term, sustained source of freshwater and many insights into how our climate may be changing. Inventorying and studying the changes in ice around the world holds promise to unlocking some of the mysteries of our planet's environment.

Actual Performance: During FY 2000, NASA's Seasonal-to-Interannual Prediction Program (NSIPP) had undertaken a series of hindcast experiments, using their coupled ocean-atmosphere-land surface models. These simulations used a simple ocean data assimilation method to initialize the ocean model by assimilating subsurface temperature data from the Tropical Ocean Global Atmosphere/Atmosphere-Ocean moorings along the Equator. The hindcasts were conducted bimonthly and covered the 1997–98 El Niño and 1998–99 La Niña periods.

The hindcasts validate the coupled model forecast strategy and give confidence to real-time forecasts. Subsequently, we have undertaken 12-month, 9-member ensemble forecasts, using the coupled model in near real-time every month. In addition, ensembles of coupled atmosphere-land surface model forecasts have been undertaken in collaboration with the International Research Institute for Climate Prediction as a contribution to their multimodel ensemble forecasts. These forecasts use the National Center for Environmental Prediction consensus forecast of sea surface temperature as the lower boundary condition.

Target Assessment: Green. Results are available to NOAA and the U.S. Navy at the Web address listed below. Results have also been submitted to the *Journal of Climate* for publication. NASA has made significant progress toward the ultimate goal.

Data Source: Ensemble forecasts are published on the Web: *http://nsipp.gsfc.nasa.gov/experimentalpredic/experimentalpredic.html*

Verification/Validation: The sample plots from the simulations published at the above Web address are included. They show Coupled General Circulation Models (CGCM), El Niño forecast, seasonal forecast for a 9-member ensemble, 6-member CGCM forecast and 12-month hindcast of Niño3 Sea Surface Temperature Anomaly simulation.

The documentation of the coupled ocean-atmosphere-land surface model forecasts is also in a draft: "Impact of Ocean Initial States and Initialization Shocks on the Evolution of the Coupled Atmosphere-ocean System," by A. Vintzileos, M.M. Rienecker, M.J. Suarez, S. Miller, and A. Borovikov, to be submitted to the *Journal of Climate*.

Performance Target: Measure production and radiative properties of aerosols produced by biomass burning in Africa based on the SAFARI 2000 field experiment and EOS instruments. Includes extensive international participation. This burning is estimated to contribute one-half of all global atmospheric aerosols. **FY 2000 Earth Science #11 (0Y11)**

The continent of Africa provides an excellent opportunity for studying pollution in the atmosphere. Understanding the transport of aerosols from fires into the atmosphere, and their behavior once airborne, allows researchers to better understand the role of pollution in affecting weather and temperature around the globe.

Actual Performance: The SAFARI 2000 field experiment was successfully completed from August 1 to September 30, 2000. The mission was able to measure production and radiative properties of aerosols produced by biomass burning in Africa as has never been done before. Validation support was also provided for the Terra mission.

Target Assessment: Green

Data Source: Safari 2000 field experiment information can be found on the following Web address: *http://www.safari2000.org*

Verification/Validation: Data from airborne, ground-based, and satellite instruments were successfully coordinated and collected. Reduction/analysis is proceeding. Reduced data should be archived and available six months after the end of the mission. The SAFARI 2000 Web site also describes the mission goals and objectives.

Performance Target: Launch the NASA-CNES JASON-1 mission. This follow-on to TOPEX/Poseidon is to achieve fourfold improvement in the accuracy of measuring ocean basin-scale sea level variability. This is one order of magnitude better than that specified for TOPEX/Poseidon. **FY 2000 Earth Science #12 (0Y12)**

Monitoring of the world's oceans on a regular basis is an important scientific key for understanding and increasing the predictive capabilities for such events as El Niño and La Niña—devastating events that cost Americans billions of dollars each year if not well prepared. Continuity of these data are important to understanding how our oceans work and how they moderate Earth's climate.

Actual Performance: The Jason-1 launch was delayed into FY 2001. The NASA-provided instrument was delivered to our international partner on time. Launch delay is due to lack of readiness by the international partner.

Target Assessment: Yellow

Data Source: GSFC monthly program review.

Verification/Validation: Monthly status is provided by the project manager to GSFC and HQ management.

Performance Target: Generate the first basin-scale high-resolution estimate of the state of the Pacific Ocean as a part of the international Global Ocean Data Assimilation Experiment (GODAE). **FY 2000 Earth Science #47 (0Y47)**

The Pacific Ocean is the birthplace of the El Niño event and much of the weather that affects North America. By better understanding the Pacific, we will gain a better understanding of how our climate works.

Actual Performance: The first results on the state of the Pacific Ocean, in terms of time series of temperature, salinity, and velocity at 46 levels on the grids of an ocean general circulation model, are currently available. The project will make a presentation at the American Meteorological Society (AMS) meeting in January.

Target Assessment: Green

Data Source: The Web abstract of the AMS presentation can be found at *http://www.ametsoc.org/AMS/meet/81annual/index.html*

Verification/Validation: An ocean data assimilation system is being implemented so as to routinely estimate the time-evolving, global, three-dimensional state of ocean circulation. Initial experiments focus on the tropical Pacific Ocean aimed at diagnosing processes underlying the 1997–1999 El Niño/La Niña event. Preliminary analysis will be presented, in addition to progress in developing the assimilation system, at the AMS meeting. The Earth Science Enterprise Physical Ocean discipline manager receives regular status on the program.

Objective: Identify natural hazards, processes, and mitigation strategies

Performance Target: Use southern California Global Positioning System (GPS) array data to understand the connection between seismic risk and crustal strain leading to earthquakes. **FY 2000 Earth Science #37 (0Y37)**

NASA, in partnership with other Federal agencies, is dedicated to improving the quality of life of all Americans through the identification of natural hazards, the study of how they occur through Earth System Science research, and partnering with others to develop mitigation strategies to save lives and property. Earthquakes are one such area where NASA data can help to mitigate risks while bringing better scientific understanding of these deadly events.

Actual Performance: Data from the Southern California Integrated GPS Network (SCIGN) was used to monitor crustal strain in southern California and assess the area's vulnerability to earthquakes. JPL, Scripps Institute of Oceanography, and the United States Geological Survey (USGS) are the operational data processing centers receiving and processing the data. The Southern California

Earthquake Center provides coordination and management of activities for SCIGN. Data and solutions for site velocities and time series of site positions are available to the research and operational communities via the Internet.

Target Assessment: Green

Data Source: *Geology*, August 1999, Vol. 27 #8

Verification/Validation: The scientific results have been reported at conferences and in scientific papers: the SCIGN data by Argus, the JPL analysis group, was published in *Geology*, August 1999, Vol. 27 #8 and cited by national news media. Current activities include continued coseismic and postseismic data analysis from the Hector Mine earthquake of October 1999.

Performance Target: Develop models to use time-varying gravity observations for the first time in Space. **FY 2000 Earth Science #38 (0Y38)**

Understanding Earth's gravitational field is another key to better scientific understanding of our living planet. Examining Earth's gravity from space may provide new insights into our home planet and its composition and some of the dynamic processes taking place below Earth's crust, e.g., changes in underground freshwater reservoirs.

Actual Performance: Several preliminary studies were performed to assess methods for modeling the data sets in order to make full use of the precise time varying geoid variations from the Gravity Recovery and Climate Experiment (GRACE). One subset of studies focused on characterizing and developing methods for de-aliasing high-frequency atmospheric and oceanic effects, using numerical modeling outputs. A second set of studies focused on the combination of gravity data from GRACE with altimeter data from Ice, Clouds, and Land Elevation Satellite (ICEsat) and in situ uplift data for the separation of past and present ice sheet mass changes. Finally, specific data analysis issues including numerical precision, measurement model parameterization, and dynamic modeling were addressed under GRACE project auspices. Preliminary results, including preliminary models, on these topics were presented at scientific conferences and published in peer reviewed literature. Under the auspices of the International Earth Rotation Service (IERS), the global Geophysical Fluids Center, with its seven Special Bureaus, is smoothly entering the operational phase to provide geophysical data sets in all Earth system components as broadly as possible for scientific research as well as societally relevant applications, e.g., natural hazards and water management.

Target Assessment: Green

Data Sources: List of Publications

Chen, J.L., C.R. Wilson, R.J. Eanes, and B.D. Tapley, 2000: "A New Assessment of Long Wavelength Gravitational Variations." *J. Geophys. Res.*, Vol. 105, No. B7, 16,271–16,278.

Chen, J.L., C.R. Wilson, R.J. Eanes, and B.D. Tapley, 1999: "Geophysical Contributions to Satellite Nodal Residual Variation" *J. Geophys. Res.,* Vol. 104, No. B10, 23,237–23,244.

Chen, J.L., C.R. Wilson, R.J. Eanes, and R.S. Nerem, 1999: "Geophysical Interpretation of Observed Geocenter Variations." *J. Geophys. Res.*, Vol. 104, No. B2, 2683–2690.

Cheng, M.K., B.D. Tapley, 1999: "Seasonal Variations in Low-degree Zonal Harmonics of the Earth's Gravity Field from Satellite Laser Ranging Observations." *J. Geophys. Res.*, 104, No. B2, 2667–2682.

Nerem, R.S., R.J. Eanes, P. Thompson, and J.L. Chen, 2000: "Observations of Annual Variations of the Earth's Gravitational Field Using Satellite Laser Ranging and Geophysical Models." *Geophy. Res. Lett.*, Vol. 27, No. 12, 1783–1786.

Cheng, M.K. and B.D. Tapley, "Observing the Time-varying Earth's gravity field from Satellite Tracking Data." Presented at the International Union of Geodesy and Geophysics 1999 Conference, Birmingham.

Cox, C.M., S.M. Klosko and B.F. Chao, "Variation in the Low-degree Geopotential Observed with SLR and Doris." Presented at the European Geophysical Society's XXV General Assembly, Nice, France, April 2000.

Verification/Validation: Above is a sampling of publications and presentations by NASA Principal Investigators dealing with various aspects of time variable gravity. This area of

investigation is attracting increasing interest from the climate change community and numerous papers have been authored over the past five years.

Performance Target: Demonstrate the utility of spaceborne data for flood plain mapping with FEMA. **FY 2000 Earth Science #39 (0Y39)**

In 2000 the NASA Administrator signed a memorandum of understanding with the FEMA Administrator that solidified a strong partnership to benefit America. Using the unique vantage point of space, NASA can provide extraordinary maps of floodplains around the country in a cost effective way—maps that can be used for disaster preparedness, flood damage assessment, and insurance industry analysis of economic impact to the Nation.

Actual Performance: NASA, FEMA, and the Army Corps of Engineers conducted Phase 1 of a series of cooperative technology demonstration pilot projects to evaluate NASA and commercially provided high-accuracy, high-resolution digital topographic and image-based information products to re-map floodplains. Phase 1 used a set of FEMA's high priority floodplain communities in the Los Angeles basin and around Sacramento, California; Virginia Beach, Virginia; Red River, North Dakota; and the Project Impact Community of San Francisco for the technology demonstration.

Phase 1 collected new Interferometric Synthetic Aperture Radar (IFSR) and Laser Altimeter data sets (using NASA and commercial airborne systems and leveraging NASA Data Buy activities), and built on existing joint data collection activities to automate the extraction of information, fusion of data, and creation of floodplain maps to enable dynamic flood modeling. Phase 1 data and results are being used to develop performance specifications for future data collections and product definitions for Phase 2. In Phase 2, NASA and FEMA will develop and initiate a long-term strategy to make operational the results of this pilot project for future floodplain mapping.

Target Assessment: Green

Data Source: FEMA-37, the FEMA specification document for floodplain mapping.

Verification/Validation: Phase 1 data and results were used to develop performance specifications for future data collections and product definitions for Phase 2, and are published in FEMA-37, the FEMA specification document for contractors performing floodplain mapping.

Performance Target: Develop an automatic volcano cloud/ash detection algorithm employing EOS data sets, for use by the FAA. **FY 2000 Earth Science #40 (0Y40)**

When volcanoes erupt, they not only pollute the atmosphere, they also create a serious hazard to commercial aviation. NASA and the FAA recognize the importance of keeping an eye on these violent events. Spaceborne monitoring of volcanoes will help to mitigate their hazardous plumes while providing important new scientific insights into their behavior.

Actual Performance: Robust algorithms that utilize EOS data and enable routine study of volcanic phenomena and their impacts on the environment have been developed. The algorithms are being validated using EOS data from the Terra spacecraft launched in December 1999. Algorithms include thermal alarms that automatically detect eruptions, the detection and retrieval of SO_2 and ash, and the analysis of ash particle-size distribution.

Routine utilization of the enhanced algorithm set, in real time, depends on the availability of MODIS and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data from the Terra satellite. Operational use of the algorithms in the future depends on successful completion of this demonstration project, availability of data, and adoption of the technique by NOAA and the FAA, for example, for use in the operational Volcano Aviation Alert Centers.

Target Assessment: Green

Data Source: The thermal anomalies detection algorithm is automated and is at the following URL: *http://modis.pgd.hawaii.edu*

Verification/Validation: Automation for real-time ash detection is being implemented. These new algorithms complement an already-existing set of algorithms used by USGS, NOAA, the FAA, and NASA, by adding new observational capability. To assist Federal agencies in

understanding the developments in volcano remote-sensing and ash detection, a series of papers were included in a recently published book *Remote-sensing of Active Volcanoes*, published by the American Geophysical Union and edited by the EOS Volcanology Team Leader and Deputy Team Leader. Specific chapters deal with (1) observations of drifting volcanic clouds from eruptions in Kamchatka, (2) the retrieval of sulfate and silicate ash masses in young plumes, (3) the monitoring of passive emission of sulfur dioxide from volcanoes, and (4) the real-time monitoring of volcanic hotspots.

Objective: Detect long-term climate change, causes, and impacts.

Performance Target: Complete the collection of satellite data needed for the 17-year cloud climatology being developed under the International Satellite Cloud Climatology Project. Data will be used to improve understanding and modeling of the role of clouds in climate and will be available in the Goddard DAAC. **FY 2000 Earth Science #13 (0Y13)**

NASA's Earth Science Enterprise is a long-term research effort dedicated to understanding how natural and human-induced changes affect our global environment. NASA uses Earth System Science to study our planet and climate change. In order to provide a strong scientific basis to policy makers we must observe our planet over long periods of time, model those observations, and analyze our findings.

Actual Performance: One such long-term observation that may lead to new understandings about the global climate is the study of clouds, vital to the transport of water around Earth and the energy budget of our planet.

All 17 years worth of data have been assembled by NASA to help understand long-term changes due to variability of clouds and their impacts on Earth's climate.

Target Assessment: Green

Data Source: NASA Langley Research Center DAAC.

Verification/Validation: Data compiled is compared among satellite, airborne, ground-based, and model results to assure that an optimal data set is provided with realistic error estimates.

Performance Target: Continue the development of global aerosol climatology data set, and analysis of this climatology in climate models. The data will be available in the GSFC DAAC. **FY 2000 Earth Science #14 (0Y14)**

Atmospheric aerosols (suspended particles serving as nuclei for raindrops) play a key role in our environment. By observing how they interact in different parts of the atmosphere, we will gain significant new understanding of how our planet's climate behaves.

Actual Performance: The Global Aerosol Climatology Project (GACP) continues to develop the data set and perform the analysis. An early version of the data is now readily available for further scientific research and analysis through the ESE data and information management system in the Goddard DAAC. The aerosol climatology currently in development will provide, for the first time, a 20-year record of the amount and distribution of aerosols over the entire planet. This will provide critical input to global climate models that will allow more accurate determination of future changes to Earth's atmosphere and its probable impact on economic and societal developments.

To date the GACP has successfully identified the satellite datasets necessary, established the best algorithms for retrieval of aerosol information from the satellite datasets, and has produced approximately 60 percent of the aerosol record and delivered it to the NASA Langley Research Center DAAC. That DAAC provides easy access and distribution of this very important dataset to the entire research community. Final delivery of the research will occur around the time of completion of the third year of funding to GACP.

Target Assessment: Green

Data Source: Information on the project is available at the Global Aerosol Climatology Project Web site: *http://gacp.giss.nasa.gov*

Verification/Validation: Data compiled is compared among satellite, airborne, ground-based, and model results to assure that an optimal data set is provided with realistic error estimates.

Performance Target: Provide for continuation of the long-term, precise measurement of the total solar irradiance with the launch of EOS Active Cavity Radiometer Irradiance Monitor (ACRIM). **FY 2000 Earth Science #15 (0Y15)**

The energy from the Sun affects our planet in many ways. By monitoring the energy that comes from the Sun into our atmosphere, and its disbursement and reflection back into space, we can better understand the Sun's effect on our planet.

Actual Performance: Measurements are continuing. The ACRIM spacecraft was launched in December 1999. Early analysis of data shows that the instrument is collecting data with required accuracy/precision.

Target Assessment: Green

Data Source: Data resides at the LaRC DAAC.

Verification/Validation: ACRIM solar irradiance data has been compared to earlier satellite instrument data and shows consistency with these earlier datasets. New data show clear gains in accuracy/precision.

Performance Target: Acquire, through a Radarsat repeat of Antarctic Mapping Mission conducted in September and October 1997, a second set of high-resolution radar data over all of Antarctica for comparison with the baseline data set acquired in 1997, to identify changes on the ice sheet. **FY 2000 Earth Science #16 (0Y16)**

NASA's Office of Earth Science believes that the study of Earth is truly an international effort. Through partnering with nations around the globe, NASA will work with the international community in acquiring a global understanding of our environment. One such partnership has been with Canada, mapping the continent of Antarctica in unprecedented detail using the Radarsat satellite—a Canadian spacecraft that uses radar to penetrate all weather conditions to map the topography of the continent in record time.

Actual Performance: The Canadian Space Agency (CSA) could not perform a special maneuver to collect required data due to satellite age and inherent risks associated with this maneuver. NASA negotiated an alternative maneuver plus additional interferometric products in order to fulfill the majority of science objectives. A new mapping program has been planned and agreed upon with the Canadians. It includes interferometric products in lieu of coverage of ~80 degrees, providing maps of ice velocities over critical areas of the Antarctic ice sheet. This approach supports the NASA science objectives of understanding the changes in Antarctic ice sheets and their impact on Earth's climate.

By the end of September 2000, the majority of Antarctica north of 80 degrees south had been successfully imaged by Radarsat for comparison with the mapping from 1997, and initial data takes, providing interferometric coverage, had also been acquired for velocity mapping. The mapping campaign extended until November 2000. This new approach has helped us obtain a good understanding of Antarctic changes over time.

Target Assessment: Green

Data Source: The Alaska SAR Facility.

Verification/Validation: NASA and the CSA signed an agreement for basic imaging coverage plus additional interferometric mapping. Basic mapping is complete and interferometric mapping was completed in November 2000.

Performance Target: Publish the first detailed estimates of thickening/thinning rates for all major ice drainage basins of the Greenland ice sheet, derived from repeated airborne laser-altimetry surveys. These measures represent the baseline data set to compare with early Geoscience Laser Altimeter System (GLAS) data (July 2001 launch). **FY 2000 Earth Science #17 (0Y17)**

Just as ice at the poles of Earth is important in understanding our global environment, ice and its movement in Greenland can give us insights into changes in temperature, sea levels and the Earth system.

Actual Performance: Aircraft laser altimetry surveys of northern Greenland in 1994 and 1999 have been combined with previously reported data from southern Greenland to analyze the recent mass balance of the entire Greenland ice sheet. NASA completed surveys and derived such estimates. Above 2000 meters altitude, the ice sheet is in balance on average, but thinning predominates close to the coast with thinning rates in some areas exceeding one meter per year.

Target Assessment: Green

Data Source: Krabill W., W. Abdalati, E. Frederick, S. Manizade, C. Martin, J. Sonntag, R. Swift, R. Thomas, W. Wright, J. Yungel, July 21, 2000, "Greenland Ice Sheet: High Elevation Balance and Peripheral Thinning", *Science*, vol. 289, 428–430.

Verification/Validation: The above article contains the detailed estimates of the thickening/thinning rates for the major ice drainage basins of the Greenland ice sheet.

Performance Target: Initiate a program of airborne mapping of layers within the Greenland ice sheet to decipher the impact of past climate variation on polar regions. **FY 2000 Earth Science #18 (0Y18)**

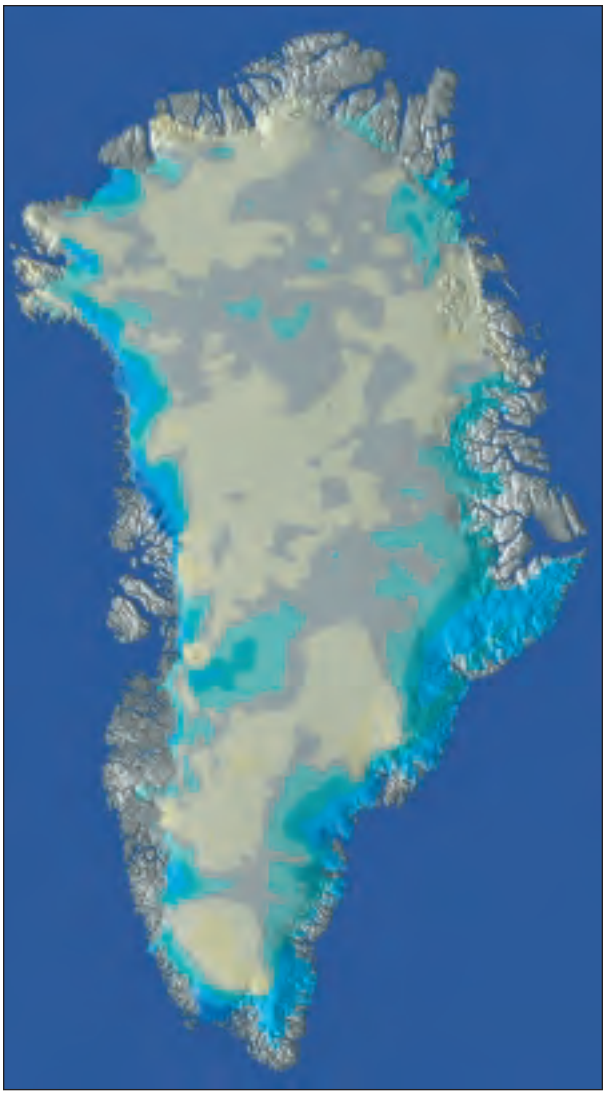
Actual Performance: The program was initiated in FY 2000 with data collected last year. Initial results turned out remarkably good data on internal layers. The project is currently in the design phase of a radar system for optimized mapping of internal layers in ice sheets. A stretch/step-frequency system, which will have variable gain to prevent saturation from near surface reflections, will be used. An approach using model-based signal processing techniques is being designed to extract weak signals from layers in the presence of off-vertical clutter. This system will be tested in FY 2001, subject to availability of the P-3B aircraft.

Target Assessment: Green

Data Source: Progress report of Principal Investigators and first-order ice thickness data is available on the Web: *http://tornado.rsl.ukans.edu/Greenlanddata.htm*

Verification/Validation: The ESE Polar Process program manager has initiated this program and is in contact with NASA Principal Investigators.

Performance Target: Develop remote-sensing instrument/technique for ocean surface salinity measurements from aircraft. The goal is to improve measurement accuracy to one order of magnitude better than available in FY 1998. The ultimate goal is the capability to globally measure sea surface salinity from space. **FY 2000 Earth Science #19 (0Y19)**



Thinning and thickening of the Greenland ice sheet using laser altimetry surveys.

Just as ocean height and temperature give us clues as to the health of our planet, so does the monitoring of salinity in the oceans.

Actual Performance: The JPL aircraft was flown in the summer of 1999 and 2000 with specially designed and fabricated ocean surface salinity instruments. Preliminary analysis to date indicates an accuracy of +/- 0.2 to 0.3 practical salinity units (PSU) was achieved. Airborne results coupled with models of the space-based measures show that an accuracy of 0.1 to 0.2 PSU can be achieved from space, which is adequate to understand the contribution of sea surface salin-

ity transport and storage of heat in the ocean, which in turn moderates Earth's climate.

Target Assessment: Green

Data Source: Recent results are shown in the report of the third meeting of the Salinity and Sea Ice Working Group (SSIWG) at the following URL: *http://www.esr.org/ssiwg3/SSIWG_3.html*

Verification/Validation: Salinities in the ocean are typically 33-32 PSU. In 1998, the level of accuracy was +/- 1 PSU, so the target for a 10-fold improvement would be 0.1 PSU. Due to pointing error on the plane L-Band, radiometer accuracy is adversely affected. From a satellite sensor, this error is much reduced. The airborne results coupled with theoretical studies now show that a monthly average of sea surface salinity, at a resolution of 1 degree latitude x 1 degree longitude can be produced with an accuracy of <0.1-0.2 PSU, which will meet the target. Important to this analysis is getting the sea surface temperature right, and also getting sea surface roughness from scatterometers. The monthly data product is suitable for ocean circulation studies. It also will be possible to produce a weekly data product, primarily for meteorological use.

Performance Target: Continue to improve the design and sophistication of a global climate system model, including use of higher resolution, in order to make it a state-of-the-art, climate system model for projecting the climatic consequences at the regional level. Improvement will be manifested in increased resolution from added computing power and better numerical representations. **FY 2000 Earth Science #20 (0Y20)**

NASA's ESE uses computer modeling to examine how Earth's climate behaves. NASA takes massive sets of data and, through the use of computers, develops conceptual models that can help mimic the behavior of the Earth system and predict different changes that may occur in our global environment, from El Niño to hurricanes and other environmental changes.

Actual Performance: The Goddard Institute for Space Studies (GISS) has achieved targeted improvements to the numerical schemes as well as reported results of simulations performed with their 2 x 2.5 degree resolution model (represents an approximately 200 km grid). The results show that they have achieved stated targets. Moreover, GISS scientists have deployed the model for assessing some specific environmental conditions.

Target Assessment: Green.

Data Source: The model evaluations together with simulations performed in these evaluations can be found on GISS's Web site, *http://www.giss.nasa.gov*

Verification/Validation: The ESE Global Atmospheric Modeling and Analysis Discipline Manager has evaluated the GISS model and simulation that have been performed. These results of the 2 x 2.5 model have set the stage for future scientific assessment of climate change due to anthropogenic influences. At this time, the model is ready for decadal and even 50-year-long integrations. GISS scientists expect more computer time to perform such simulations next year.

Objective: Understand the causes of variation in atmospheric ozone concentration and distribution.

Performance Target: Implement SAGE III Ozone Loss and Validation Experiment (SOLVE). Measurements were made October 1999 to March 2000 in Arctic high-latitude regions from the NASA DC-8 and ER-2 aircraft, as well as balloon platforms. Correlative data was acquired to validate SAGE III data and assess high-latitude ozone loss. **FY 2000 Earth Science #22 (0Y22)**

Earth's ozone layer provides the protective shield that keeps life on planet Earth alive.

Actual Performance: NASA's ESE monitors ozone depletion and studies how human-induced and natural climatic events effect this important component of our atmosphere.

The SOLVE campaign successfully completed all objectives.

Target Assessment: Green

Data Source: Information and data from the SOLVE Campaign can be viewed at the SOLVE Web site: *http://cloud1.arc.nasa.gov/solve/*

Verification/Validation: The SOLVE program manager stated that all major program objectives were achieved during the campaign. Correlative data for SAGE III was collected.

Performance Target: Complete analysis and publication of Production Efficiency Model (PEM)—Tropics-B (PEM-T-B) field experiment. **FY 2000 Earth Science #23 (0Y23)**

NASA also monitors other atmospheric conditions for development of models about our planet's climate. Examining aerosols and components of the atmosphere will help researchers understand how regional climate interacts with global events.

Actual Performance: Two special sessions for PEM-T-B results were presented at the Spring 2000 American Geophysical Union (AGU) meeting. PEM-T-B manuscripts were submitted to the *Journal of Geophysical Research* (*JGR*) in August 2000.

Target Assessment: Green

Data Source: Spring 2000 AGU abstracts.

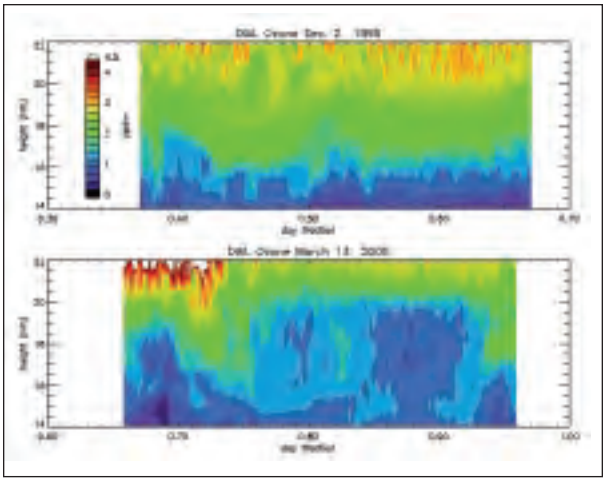
Verification/Validation: Spring 2000 AGU abstracts were published in the *EOS* transactions of the American Geophysical Union. *JGR* Special Section continues to be on track with manuscripts now in review cycle.

Performance Target: Complete the Troposphere Chemistry Program aircraft instrument size and weight reductions (by ~40 percent) initiative. **FY 2000 Earth Science #24 (0Y24)**

As America's leading civil space research and development agency, NASA is constantly trying to improve technologies for instruments that acquire the science data used by its researchers.

Actual Performance: Two instruments delivered at 40 percent reduction (weight), one at 25 percent and a final instrument estimated completion at 55 percent. Overall instrument performance meets the target reduction 40 percent goal.

Target Assessment: Green



North polar ozone concentration comparison from the SOLVE Campaign. December 1999 to March 2000 showed a 70 percent ozone loss.

Data Source: General Technology Electric (GTE) Project Office.

Verification/Validation: GTE Project Office maintains instrument weight and dimensions; tracking of detailed progress is performed by GTE project manager and deputy manager. NASA ESE Tropospheric Chemistry discipline manager interfaces with GTE to status target achievement.

Performance Target: Complete planning for major new 2001 airborne/unpiloted aerospace vehicle mission that will use a smaller Troposphere Chemistry aircraft instrument. **FY 2000 Earth Science #25 (0Y25)**

NASA utilizes unpiloted aerial vehicles to conduct high altitude research in Earth Science.

Actual Performance: The mission plan was completed per the target.

Target Assessment: Green

Data Source: Principal Investigator at Harvard University has created the mission plan.

Verification/Validation: NASA Tropospheric Chemistry program manager obtained and reviewed mission plan.

Goal: Disseminate information about the Earth system.

Objective: Implement open, distributed, and responsive data system architectures.

Performance Target: EOS Data and Information System (EOSDIS) will make available data on prediction, land surface, and climate to users within five days. **FY 2000 Earth Science #26 (0Y26)**

If the research community at large cannot access the data from NASA science programs, important science discoveries will not be made. NASA is committed to making science data available in a timely manner to the research community through a data distribution system known as "EOSDIS."

Actual Performance: The median time to distribute EOSDIS data products was one day. The average time to distribute data products was less than four days.

Target Assessment: Blue.

Data Source: EOSDIS data system.

Verification/Validation: ESE data and information is currently delivered to the scientists, practitioners, and policy makers from three different systems. A performance measure is an average delivery time for these systems, Version 0, EOSDIS Core System (ECS), and the Federation of Earth Science Information Partners (ESIP) to the users. FY 2000 is the first year that ESE is reporting metric data from federation ESIPs as part of this goal. The majority (~95 percent) of data deliveries were from the Version 0 systems, the ECS systems accounted for four percent of the data, and less than one percent of all data deliveries came from the Federation's ESIPs.

The delivery time for orders from the Version 0 systems is based on eleven months of data gathered and verified by the Version 0 Statistics Collection and Reporting System (SCRS, *http://ulabibm.gsfc.nasa.gov/~stats/charts/*), ending in August 2000. The median delivery time for orders from the Version 0 system was less than one day (50 percent of all orders are delivered automatically via electronic means). The average time for a delivery was 3.26 days.

The median and average delivery times for products from ECS are not yet available. However, over 95 percent of the ECS products were ordered for electronic delivery. The typical time for such electronic delivery is less than six hours. Because the total number of products delivered from ECS in FY 2000 was small (only four percent of the total), we have not included the ECS statistics in this metric.

The median and average delivery time for the ESIP 2 products was less than five days in FY 2000, as reported by the individual ESIPs to the Federation metrics working group.

Performance Target: EOSDIS will double the volume of data archived compared to FY 1998 (target is 368 terabytes). **FY 2000 Earth Science #27 (0Y27)**

As NASA launches an armada of Earth-observing satellites, we expect to gain vast new amounts of science data that we will successfully archive and make available to our user community.

Actual Performance: ESE had well over 500 TB of data in our archives at the end of FY 2000, greatly exceeding the goal of 368 TBs. The volume increase is due in part to the new data from the Terra satellite and the addition of data from the Federation ESIP 2s. Of the total amount, 440 TB were archived in the Version 0 systems, over 100 TB were archived in the ECS systems and over six TB were archived by the Federation ESIPs.

Target Assessment: Blue.

Data Source: EOS Data Gathering and Reporting System, *http://edgrs.gsfc.nasa.gov:8000*

Verification/Validation: The data volume numbers for the Version 0 systems are provided by the DAACs in the Science Data Plan (*http://spsosun.gsfc.nasa.gov/spso/sdp/sdphomepage.html*). The volume for ECS is obtained from the EOS Data Gathering and Reporting System, *http://edgrs.gsfc.nasa.gov:8000* The ESIP volumes are provided by the individual ESIPs to the Federation metrics working group. The final Version 0 and ECS archive volume numbers are now available. The Version 0 volume is dominated by the large volume of Synthetic Aperture Radar (SAR) satellite data archived at the Alaska

SAR Facility (ASF). Since our estimate of FY 2000 volume at ASF is based on projections from FY 1999, the final EOSDIS archive volume size may have to be revised downward; however, the final result will still exceed the FY 2000 target.

Performance Target: EOSDIS will increase the number of distinct customers by 20 percent compared to FY 1998 (target is 1.29 million distinct users). **FY 2000 Earth Science #28 (0Y28)**

NASA is always looking for new users of its Earth Science data. To get the best return on taxpayer investment, NASA hopes to engage researchers of Earth Science throughout the country and around the globe.

Actual Performance: During FY 2000, more than 1.53 million distinct customers accessed the DAAC's and ESIP 2s, exceeding the performance target of 1.29 million users by 20 percent. This increase was due to the increasing number of users coming to the DAACs for Landsat 7 and Terra information and data products and to the addition of the users from the Federation.

Target Assessment: Blue.

Data Source: Customer data is collected by the Statistics Collection and Reporting System (*http://ulabibm.gsfc.nasa.gov/~stats/charts/*)

Verification/Validation: The numbers of distinct customers accessing Version 0 and ECS were projected by taking the number of distinct users from 11 months of data ending in August 2000 (1.36 million) and extrapolating for an additional month (to 1.49 million). Customers were identified by their full names (where possible) or email identifiers, and the customer contact databases were screened to remove duplicate users. The number of distinct accesses for the Federation ESIP 2s was reported by the ESIPs to the Federation metrics working group to be 40,103. Thus, the total estimated number of distinct users accessing EOSDIS in FY 2000 was 1.53 million.

Performance Target: EOSDIS will increase products delivered from the DAACs by 10 percent compared to FY 1998 (target is 4.96 million products delivered). **FY 2000 Earth Science #29 (0Y29)**

NASA knows that while storing data is important, delivering products to its customers is vital for the continuation of cutting-edge research in Earth System Science.

Actual Performance: In FY 2000, EOSDIS exceeded our performance target of 4.96 million data products by 80 percent as the number of data product deliveries surpassed 8.8 million. We attribute this success to the growing interest in Earth Science Enterprise information and data products, due to the successful launches of the Terra and Landsat 7 and general awareness of Earth Science and global environmental research.

Target Assessment: Blue.

Data Source: EOSDIS data system.

Verification/Validation: The number of products delivered from the Version 0 systems was 7.49 million in the 11 months ending in August 2000. Extrapolating through the end of the fiscal year results in a projected total at the end of the year of 8.17 million products delivered. In FY 2000, NASA also began delivering products from the Terra and Landsat 7 missions. In FY 2000, over 85 thousand products were delivered from ECS. A significant number of products was delivered by the Federation ESIP 2s. The ESIP 2 number was estimated from data for the first quarter of FY 2000. During that quarter, the ESIP 2s delivered 146,000 products. Extrapolating to the full year (multiplying by 4) results in a projected value of 0.59 million deliveries by the ESIP 2s in FY 2000. Adding the Version 0, ECS, and ESIP 2 totals gives a projected total value of 8.85 million products delivered by EOSDIS.

Objective: Increase public understanding of Earth system through education and outreach.

Performance Target: Award 50 new graduate student/education research grants and 20 early career fellowships in Earth Science. **FY 2000 Earth Science #30 (0Y30)**

One of NASA's primary goals as an Agency is to communicate knowledge. NASA is dedicated to informing the American people as to how their investment in America's space program is working and how it is benefiting the Nation. Through education and outreach efforts, NASA is succeeding in returning to the taxpayer the information and knowledge we generate in Earth System Science.

Actual Performance: Fifty-one new graduate fellowships awarded to students pursuing their Masters of Science and Ph.D. degrees in Earth System Science disciplines. Seventeen Early Career Research (ECR) grants are being continued (second of three-year cycle), and an NRA was issued in April 2000 to award at least 13 new ECR grants in early FY 2001 to support education and research by young faculty members at U.S. universities and institutions of higher education.

Target Assessment: Green

Data Source: NASA Grants/Contract Office maintains fellowship awards.

Verification/Validation: The ESE applications office is responsible to award the fellowships and ensure qualified candidates. The manager reviews each award and is therefore aware of target achievement.

Performance Target: Conduct at least 300 workshops to train teachers in the use of ESE education products. **FY 2000 Earth Science #31 (0Y31)**

NASA recognizes the role of education, and teachers in particular, as the catalyst by which America's young people can become interested and proficient in math, sciences, and engineering. An American public lacking in these vital skills would be devastating to our Nation's future. NASA is a government leader in partnering with the Nation's education infrastructure to ensure that the excitement and importance of Earth System Science will continue to be part of our schools' curricula.

Actual performance: 340 workshops were conducted.

Target Assessment: Blue

Data Source: The NASA Education Division EdCATAS System.

Verification/Validation: Training of teachers in the use of ESE education products translates into more students using products and a deeper understanding of the world in which they live. Training of journalists develops more knowledgeable journalists reporting on Earth Science issues. The ESE applications program manager evaluates workshop effectiveness.

GLOBE activity at Southern University at Baton Rouge.

Performance Target: Increase the number of schools participating in GLOBE to 10,500, a 30 percent increase over FY 1999. Increase participating countries to 77 from 72 in FY 1999. **FY 2000 Earth Science #32 (0Y32)**

NASA understands that Earth System Science is of importance not just to America, but to the world as a whole. NASA has partnered with countries around the world on their education efforts.

Actual Performance: Currently participating are 9,643 schools and 94 countries. This represents 91 percent of the desired schools goal and 120 percent of the desired countries. Based on the new emphasis on teachers trained versus number of schools, we believe the performance goal was met.

Target Assessment: Yellow

Data Source: GLOBE Program Office Database.

Verification/Validation: The metric of showing schools has since been discounted as a meaningful measure. The focus should be on the number of teachers trained, together with the number of schools, rather than just the number of schools. The reason being the probability of a sustainable, viable, reliable program at a school where only one teacher had been trained was lower than at a school where two or more teachers were trained. Therefore, GLOBE began to

request schools put at least two teachers through the training to become a GLOBE school. The result is there has been a decrease in the rate at which new schools have been signed on but an increase in the number of teachers trained and the number of measurements which are being taken and submitted to the database.

Objective: Support the development of a robust commercial remote-sensing industry.

Performance Target: Focus Earth Observation Commercialization Applications Program (EOCAP) joint commercial applications research to develop 20 new market commercial products (e.g., oil spill containment software by EarthSat; map sheets products by ERDAS, Inc.) **FY 2000 Earth Science #44 (0Y44)**

NASA is a Government research and development Agency, dedicated to the pursuit of advancing science and technology in the United States. NASA is not a corporation, nor is it interested in competing with commercial enterprises. NASA is dedicated to helping support the development of a robust, domestic, commercial, remote-sensing industry.

Actual Performance: The EOCAP program has three major efforts underway that develop new market commercial products. EOCAP 97, initiated in FY 1997 was a three-year effort aimed for product generation in FY 2000 and FY 2001. One product completed development earlier than anticipated in late FY 1999, five completed development in FY 2000, and two are continuing development into FY 2001. EOCAP SAR, initiated in FY 1998, is focused on the development of SAR applications. Nine companies were participants in the program. Three have developed products that are marketable, and the six remaining are still in development. EOCAP Hyperspectral was also initiated in FY 1998 and is focused on the development of applications for hyperspectral data. Four products were in development at the end of FY 2000 and were making progress toward product release.

Target Assessment: Yellow

Nine EOCAP investigators had an identifiable commercial product. Twelve EOCAP investigators are working toward a commercial product.

Data Source: The EOCAP project manager at Stennis Space Center.

Verification/Validation: The EOCAP program manager receives quarterly and yearly progress reports from EOCAP investigators. The EOCAP program manager maintains contractor information, provides a matrix of program participants and products in generation, and provides a status to the ESE Application Division Director. The Commercial Remote-sensing Program (CRSP) Web site contains links to the companies' home Web sites where these products can be found. The CRSP Web site is *http://www.crsp.ssc.nasa.gov/* In the menu section, click EOCAP; on the new screen, click EOCAP Projects.

Performance Target: Provide three commercial sources of science data from the Scientific Data Purchase for global change research and applications. **FY 2000 Earth Science #45 (0Y45)**

NASA is a regular customer of commercial remote-sensing companies, purchasing data for scientific research when appropriate.

Actual Performance: Under the Science Data Purchase, Positive Systems, IKONOS and Earthwatch/Intermap have been validated.

Target Assessment: Green

Data Source: *http://www.crsp.nasa.gov/databuy*

Verification/Validation: Data vendors and products can be located at the CRSP Web site. Validation ensures that the commercial sources are adequate for global change research and applications.

Performance Target: Develop two new validated commercial information products as a result of verification and validation (V&V) partnerships with industry. **FY 2000 Earth Science #46 (0Y46)**

NASA partners with industry in the development of new products that are made available to the private sector.

Actual Performance: The EarthSat data product and an information product produced by Air-O-Space have been validated through the CRSP V&V program.

Target Assessment: Green

Data Source: CRSP Program Office.

Verification/Validation: Company proprietary reports are on file in the CRSP office; ISO records are available for the EarthSat product; a report is available for the Air-O-Space V&V of Positive Systems' ADAR 500.

Goal: Enable the productive use of Earth science technology in the public and private sectors.

Objective: Develop and transfer advanced remote-sensing technologies.

Performance Target: Achieve a 50 percent reduction in mass for future land imaging instruments. **FY 2000 Earth Science #33 (0Y33)**

NASA is a leader in technology development, and believes strongly that new technologies should benefit American industry and the American public.

Actual Performance: The EO-1 Advanced Land Imager (ALI) instrument met this target. This translates into a significant reduction in the cost of placing a land imaging instrument in orbit.

Target Assessment: Blue

Data Source: EO-1 ALI instrument specifications.

Verification/Validation: The Enhanced Thematic Mapper (ETM+) on Landsat 7 had a mass of 425 kg. EO-1 ALI instrument had a mass of 100 kg, 77 percent less than ETM+.

Performance Target: Transfer at least one technology development to a commercial entity for operational use. **FY 2000 Earth Science #34 (0Y34)**

NASA is committed to getting new technologies out the door and into the marketplace.

Actual Performance: Completed 2 technology transfers: 1) Data Information and Access Link (DIAL) software in use by over 50 users in NASA science, U.S. and international teams; 2) Dynamic Query Preview user interface techniques and software transferred to EOSDIS Data Gateway system.

Target Assessment: Green

Data Source: DIAL statistics of 12 NASA project teams, 6 ESIPs, 17 U.S. organizations handling remote-sensing data, and 20 international users are kept by the software developers and reported under contract. Dynamic Query Preview information is provided by the NASA manager of the EOSDIS Data Gateway system.

Verification/Validation: 1) DIAL is a free software system enabling small volume Earth Science data providers to access and manage Hierarchical Data Format-EOS data on PC-scale hosts. Its extensive acceptance into the science community is supporting the ESIP Federation; Global Observation Forest Cover; Global Observation Information Networks; multiple science instrument teams within EOS; as well as NOAA National Environmental Satellite, Data, and Information Service; Department of Defense; and international projects with Japan, German Aerospace Center–Remote-sensing Data Center (DRL-DFD), Brazil, China, Thailand, and Canada. 2) Dynamic Query Preview is a set of user interface techniques and software for interactively quantifying the volume of responses to a query for data from very large data archives as found in the EOSDIS. This provides users of the EOSDIS Data Gateway with the insight to avoid unproductive data queries (from user's time and EOSDIS system processing resources) that produce either no hits or many thousands of hits. This technology has also been infused into the Global Land Cover ESIP.

Performance Target: Advance at least 25 percent of funded instrument technology developments one Technology Readiness Level (TRL) to enable future science missions and reduce their total cost. **FY 2000 Earth Science #35 (0Y35)**

NASA realizes that without a strong commitment to technology development, the Agency will not be able to continue our scientific research in the new millennium. NASA is dedicated to the concept of advanced technology development as one of the keys to reducing risks and cost of its future satellites.

Actual Performance: Twenty of 27, or 74 percent, of incubator instruments advanced by one or more TRLs in FY 2000, exceeding the target by 49 percent.

Target Assessment: Blue

Data Source: TRL assessments in the Instrument Incubator Program (IIP) are made initially by the project Principal Investigators, then reviewed by IIP program officials for consistency and accuracy. TRLs are somewhat subjective, but the review at the program level ensures that the final levels assigned, for assessment purposes, appropriately represent the progress of individual projects.

Verification/Validation: The instrument incubator is in the middle year of its first set of three-year projects (note there are also some 1- and 2-year projects). In terms of TRL advance, the middle year is the most favorable with many projects advancing through one or more levels.

Objective: Make major scientific contributions to national and international environmental assessments.

Performance Target: Sponsor two regional assessment studies of environmental variations and natural resources vulnerability. **FY 2000 Earth Science #48 (0Y48)**

NASA supports both American and international scientific teams that examine Earth and its environment and foster dialogs among researchers that conduct sound scientific research and explore new scientific frontiers. The results from such scientific research will enable policymakers to establish sound environmental policy decisions without compromising a balanced economic and industrial development.

Actual Performance: Three-year environmental studies are underway in the southeast United States, the northern Great Plains, and for the Native Peoples/Native Homelands. The studies will be completed during FY 2001.

Target Assessment: Green

Data Source: NASA ESE program manager for Applications.

Verification/Validation: Program manager contacted all three grantees for the National Assessment activities for accomplishments and plans reporting in June 2000. A white paper was written that summarizes progress to date.

Performance Target: Complete the contribution to the First National Assessment of the Potential Consequences of Climate Variability and Change: provide climate scenario information, support the National Synthesis, conduct several regional U.S. analyses, and support research for sector analyses. ESE provided its contributions to the United States National Assessment Coordination Office. **FY 2000 Earth Science #5 (0Y5)**

Climate variability and change effects the lives of all Americans. NASA has worked aggressively with other organizations to assess how these climate changes may affect all aspects of our environment.

Actual Performance: ESE has completed contributions to the First National Assessment Synthesis Documents (Overview and Foundations). ESE provided its contributions to the National Assessment Coordination Officer.

Target Assessment: Green

Data Source: First National Assessment Synthesis Document.

Verification/Validation: ESE reviewed the chapters submitted from the regions for which we sponsored the assessments. ESE conducted a complete review of the full set of draft documents and recommended release for public comment (released in June 2000).

Performance Target: Conduct the first regional international assessment in South Africa: quantify the effects of climate variability and management practices on the environment. Publish in open literature and provide analyses to the Intergovernmental Panel on Climate Change (IPCC) for their 2000 assessment report. **FY 2000 Earth Science #6 (0Y6)**

NASA is a leader in the international community in the field of climate research. NASA understands that the global environment is an ideal subject for the vantage point of space. NASA conducts spaceborne research of our planet and complements these with in situ and airborne observations as

needed. NASA, working with our international partners, continues to unravel some of the mysteries of our planet.

Actual Performance: One such effort was the South African Fire-Atmospheric Research Initiative (SAFARI). SAFARI is now complete and has been a huge success in terms of data collection. Publications are planned, ranging from climate forcing to management practices. Early results from the February wet season are in press and show significantly higher rates of photosynthesis than previously reported for savanna systems.

Target Assessment: Yellow—The SAFARI campaign was not completed until the end of FY 2000, so publication was not possible in FY 2000. Publication of the assessment will be accomplished in FY 2001.

Data Source: Information on the SAFARI campaign can be found at the SAFARI Web site: *http://www.safari2000.org*

SAFARI science status and goals can be found at the following Web site: *http://safari.gecp.virginia.edu* Data were collected from Terra, AVHRR, SeaWiFS, and Landsat 7, and are available via the Internet.

Verification/Validation: Evaluation of preliminary results, by the NASA Ecology and Atmospheric Chemistry program manager, from the July/August intensive campaign, show aerosol loadings similar to those found over the Amazon basin and high Tropospheric ozone levels. Once data analyses have begun, results will be provided in time for the IPCC regional assessment.

Performance Target: Provide the first global, regional, and country-by-country forest cover inventory in support of national and international needs of research, operational, and policy communities. Publish this information and provide to IPCC and the International Geosphere-Biosphere Programme for their 2000 assessment report. **FY 2000 Earth Science #8 (0Y8)**

NASA contributes vital data and information to international scientific and research organizations. By combining NASA data and results with those of our international partners, NASA is helping to provide sound science to better inform decisionmakers about our planet's environment.

Actual Performance: The University of Maryland has produced and published a global map of tree density based on satellite, observations that is being used by the United Nations scientific research organization. This work is also being published in open literature.

Target Assessment: Green

Data Sources: Up-to-date status of this work can be found at the following Web sites:
http://esip.umiacs.umd.edu/documents/treecover.html
http://www.bsrsi.msu.edu/trfic/index.html
http://esip.umiacs.umd.edu/documents/1km.htm

Verification/Validation: NASA Earth Science program manager for Ecology and Atmospheric Chemistry reviews University of Maryland products and the IPCC report.

Objective: Extend the use of Earth Science research for national, State, and local applications.

Performance Target: At least one Regional Earth Science Applications Center (RESAC) becomes self-sustaining. Continue funding for the remaining centers. **FY 2000 Earth Science #41 (0Y41)**

The use of Earth Science data for practical applications is vast. NASA is committed to demonstrating that the investment America is making fuels the scientific exploration and discovery of our home Earth, but also has practical applications to people in the United States and around the world now and in the future. NASA's Earth Science Applications program is showing how the unique vantage point of space provides real world benefits to Americans today.

Actual Performance: The RESACs are part of a three-year funded program that began in March 1999. The program involved the RESACs generating self-sustaining activities in the area of remote-sensing applications or becoming self-sustaining in their own right, and being able to accomplish the objectives of such a plan by the end of the of the program, approximately March 2002. None of the seven RESACs were self-sustaining by the end of FY 2000, since they have been operational only one year. However, the University of Kansas–Great Plains RESAC has spun off a self-sustaining commercial venture. Some of the other RESAC's are making

significant progress in collaborating with the industry on commercial activities. The overall intent was that self-sustainment would occur at the end of the three-year cycle.

Target Assessment: Yellow—Creation of a self-sustaining enterprise from a RESAC meets the intent of the target.

Data Source: Annual Progress Presentations; special purpose briefings.

Verification/Validation: Specific to the University of Kansas, the Great Plains RESAC has developed the Green Report and agricultural crop yield models for corn winter wheat and soybean for the continental United States. These prototype products are now being developed as value-added products for use in all aspects of agricultural strategic planning from supply through retail. These value-added products are being jointly developed and marketed with non-NASA funds through two companies, Terra Metrics, Inc. (TMI) and Planalytics, Inc. These products developed as Web-based products for use by the broad agricultural community and as custom products to support strategic planning activities. To date, in excess of $2 million in non-NASA funds have been invested in the development of these products and substantial additional funds have already been omitted for further development and refinement of these products.

Performance Target: Implement at least five joint applications research projects/partnerships with State and local governments in remote-sensing applications. **FY 2000 Earth Science #43 (0Y43)**

NASA is committed to working with State and local governments on applying Earth Science research to real world applications. NASA is aggressively seeking partnerships on the State and local level to bring Earth Science research to the public at large.

Actual Performance: Partnerships established with: 1) Cayuga County, New York; 2) Western Governors' Association (representing State governments), 3) Aerospace States Association (representing State governments); 4) the National States Geographic Information Council; 5) University of Missouri (representing the City of Springfield, Missouri); 6) the State of North Carolina; and 7) the State of Alaska. Additionally, there are seven projects under the EOSDIS Synergy Contract with Raytheon Corporation that are focused on applications using remote-sensing data with State and local governments.

Target Assessment: Green

Data Source: Applications Division Partnerships program manager, GSFC grants office.

Verification/Validation: Contractual relationships (e.g., grants) have been established with the first five organizations above and the seven projects under the Synergy Contract. Cooperation with the State of North Carolina and the State of Alaska has been in conjunction with FEMA, and in the case of Alaska, with the Army Corps of Engineers and the United States Geological Survey. Below is a listing of the grants and projects.

(1) Cayuga County, New York—Phase III: Deploying ESE Pilot Information Programs for State and local governments in the Northeast (Grant NAG13-00044); Principal Investigator (PI): Mr. Robert Brower.
(2) Western Governors' Association—Dissemination of NASA Earth Science data, technology and expertise to the western States and evaluation of their utility in State and local policy (Grant NAG5-9879); PI: Mr. Chris McKinnon.
(3) Aerospace States Association—State Geospatial Applications outreach and education (Grant NAG5-9628); PI: Mr. James M. Pagliasotti.
(4) National States Geographic Information Council—Direct State and local government participation in NASA outreach and applications activities; PI: Mr. Bill Burgess. NOTE: This project did start in FY 1999; however, the momentum and key workshops that were done were accomplished in FY 2000.
(5) University of Missouri—Center for Local and Regional Applications (CLARA) of Remote-sensing Technologies Projects (Grant NAG13-00006).

The EOSDIS Synergy Contract with Raytheon Corporation. These projects were all started in CY 2000. The contract (NAS5-6000-ESD NO-97) was initiated with Raytheon in January 2000. The projects are listed below:

(1) University of Arizona; PI: Dr. Charles Hutchinson

Project Partners/Users: Arizona Office of State Cartographer, Arizona Department of Fish and Game, Nature Conservancy's Arizona Chapter, Arizona Legislative Natural Resources Discussion Group.

Applications: Using a combination of detailed Landsat, AVHRR, and Moderate Resolution Imaging Spectroradiometer data to develop detailed seasonal habitat maps to predict elk population and density.

(2) University of Arizona; PI: Dr. Soroosh Sorooshian

Project Partners/Users: Cities of Phoenix and Tucson, Arizona; USGA; U.S. Army Corps of Engineers; Colorado Basin River Forecast Center.

Applications: Using AVHRR and MODIS data to develop high-resolution snow cover and water equivalent maps over entire western United States and derived watershed status reports that integrate remote-sensing data with existing ground observations.

(3) University of Idaho; PI: Dr. Richard Allen

Project Partners/Users: Idaho Department of Water Resources.

Applications: Using the Surface Energy Balance Algorithm for Land (SEBAL), Idaho Dept of Water Resources is computing and mapping the amount of water that is transpired by vegetation.

(4) University of Missouri; PI: Dr. Andrew Blanchard

Project Partners/Users: Boone County and City of Columbia, Missouri.

Applications: Using Moderate-Resolution Imaging Spectroradiometer and Landsat 7, the project is defining city/county planning requirements working directly with local government planners, providing an assessment of terrestrial biodiversity across Boone County and integrating data for urban planning.

(5) University of Hawaii; PI: Dr. Peter Mouginis-Mark

Project Partners/Users: Hawaii State Civil Defense, Pacific Disaster Center, FEMA, Pacific Command.

Applications: Developing the capability for automated production of cloud-free base images of Landsat 7 for disaster planning and evacuation procedures.

(6) University of Texas; PI: Dr. Byron Tapley

Project Partners/Users: Texas Natural Resources Information System, Bureau of Economic Geology, Texas General Land Office, Governor's Division for Emergency Management, Texas Parks and Wildlife, Texas Natural Resources Conservation Commission, Texas Water Development Board, Texas Department of Agriculture, U.S. Forest Service, Texas Railroad Commission.

Applications: Using hyper-spectral, multisensor, multiresolution remote-sensing data for managing two environmental conditions: current drought and Texas coastal zone hazards monitoring.

(7) Towson University; PI: Dr. Jay Morgan

Project Partners/Users: Maryland Department of Natural Resources, Maryland Department of Planning, Baltimore County Department of Environmental Protection and Resource Management, Montgomery County Department of Parks and Planning, and Maryland Space Grant Consortium.

Applications: Landsat 7 data is being used to identify protected watersheds, impacted watersheds, and degraded watersheds.

Objective: Successfully launch spacecraft.

Performance Target: The Earth Science Enterprise will successfully launch three spacecraft and deliver two instruments for international launches within 10 percent of budget on average. **FY 2000 Earth Science #36 (0Y36)**

NASA has begun to launch its next generation of Earth-observing satellites. These vital satellites will provide the data needed to examine and understand practically every aspect of our home planet. With the successful launch and subsequent data collection from the flagship satellite EOS Terra, NASA has entered into a new era of Earth System Science.

Actual Performance: There have been five launches accomplished: EOS Terra, Active Cavity Radiometer Irradiance MonitorSat, Shuttle Radar Topography Mission, Geosynchronous Operational Environmental Satellite-L, and NOAA-L. NASA successfully delivered instruments to the following international launches/spacecraft: SAC-C (Argentina), CHAMP (Germany), METEOR-3M (Russia), Jason (France) and FedSat. The cost growth for these projects on average from the FY 2000 President's budget baseline was seven percent.

Target Assessment: Green

Data Source: For launches, Office of Earth Science Web site: *www.earth.nasa.gov/missions/index.html*. For cost information, data is held by the Resources Team Lead for the Office of Earth Science.

Verification/Validation: To determine cost growth, the FY 2000 President's budget was compared with actuals at the end of FY 2000. For spacecraft launches and instrument development, the Web address above has a current list of missions including launch and delivery dates.

Earth Science Data Validation and Verification

NASA is committed to providing the best possible scientific and technical products to its user community. To do so requires vigilance on the part of the Enterprise in validating and verifying its data and information on a regular basis, and assessing how it is satisfying its sponsors and customers.

The ESE regularly reviews its performance targets as part of an existing monthly management review process. Tracking current performance on a monthly basis for each specific annual performance target enables the Enterprise to institute measures to ensure improvement and progress toward meeting its strategic goals. Each performance target has an owner accountable for its success or failure. At the end of the fiscal year each target owner was asked to write a self-assessment as to whether or not the target was achieved. The validity of this assessment was reviewed by the ESE Program Division Director, the Business Division Director, and the Associate Administrator for Earth Science.

After internal review, the ESE then relied on external expert review to validate and verify performance against the FY 2000 targets. The Earth System Science and Applications Advisory Committee (ESSAAC) of the NASA Advisory Council conducted its annual assessment of the Enterprise's near-term science objectives and provided a qualitative assessment as to whether the objective was met. ESSAAC deliberated internally and rendered its own assessment, which confirmed ESE's self-assessment. The assessment was then provided to the NASA Advisory Council, which also reviewed the self-assessment prior to being submitted to the Office of the Chief Financial Officer.

In general, we find an improvement in our ability to define effective and meaningful metrics and to put in place the rigorous and proper process to monitor their progress. We believe further process improvements will be achieved in ensuing years. GPRA is helping ESE management to focus strategically on allocation of its appropriated resources in the most effective ways to meet our national strategic goals and objectives.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Understand the causes and consequences of land cover/land use change.	9Y1	Begin to refresh the global archive of 30-meter land imagery from Landsat 7 two to three times per year. A single global archive has not been constructed since the late 1970's. Landsat 7 also includes a 15-meter panchromatic band, for the study of ecosystems disturbance.	Yellow	0Y1	Continue the development of a global land cover/use change data set based on Landsat and EOS instrument, at seasonal refresh rate.	Green	Landsat 7 and AVHRR continue to provide global land cover/land use change data at seasonal refresh rates. EOS MODIS launched in FY 2000 is providing additional data products.
	9Y2	Begin to collect near-daily global measurements of the terrestrial biosphere from instruments on the Earth Observing System TERRA spacecraft.	Yellow	0Y2	Continue to collect near-daily global measurements of the terrestrial biosphere (index of terrestrial photosynthetic processes from which calculations of carbon uptake are made) from instruments on EOS AM-1 (TERRA).	Green	With the launch of Terra, the MODIS instrument has begun measurement of the terrestrial biosphere on a near-daily basis.
	9Y3	Collect near-daily global measurements of ocean color (an index of ocean productivity from which calculations of ocean carbon uptake are made).	Yellow	0Y3	Continue the ocean color time series with 60% global coverage every 4 days—a 35% improvement over FY 1999.	Green	In FY 2000, SeaWIFS improved global coverage to near 100% of the visible portion of the Earth every 2 days. Cloud coverage reduces actual coverage to 50%–60% but this still is an improvement over FY 1999. The MODIS instrument on TERRA will improve ocean coverage nearly fourfold.
				0Y4	SIMBIOS will merge MODIS ocean color data into the global ocean color time series, which began with Ocean Color Temperature Sensor (OCTS) and SeaWiFS. Use time series to understand and predict response of the marine ecosystem to climate change. Make data set available via the Goddard DAAC.	Yellow	New target.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
				0Y7	Produce near-real-time fire monitoring and impact assessment based on Landsat and EOS inventory and process monitoring to provide an observational foundation for monitoring change in ecosystem productivity and disturbance. Post near-real-time assessments on a Web site for quick access by researchers and regional authorities.	Green	New target.
Predict seasonal-to-interannual climate variations.	9Y4	Begin the second of a three-year sequence of instantaneous measurements of rainfall rates & monthly accumulations in the global tropics. This will be the first-ever measurement of global tropical rainfall. Current uncertainty in global tropical rainfall estimates is 50%; TRMM data will reduce this uncertainty to 10 percent, an 80% improvement.	Green	0Y9	Establish a benchmark for global and regional rainfall measurements by combining TRMM measurements with measurements from other sources. Create maps of the diurnal cycle of precipitation for the first time. Combine the existing ten-year data set with TRMM measurements to validate climate models and demonstrate the impact of rainfall on short-term weather forecasting. Distribute through the Goddard DAAC for ease of access to science and operational users.	Green	Tropical rainfall estimates from TRMM have further converged and been combined with other satellite and surface-based measurements) to establish a standard for comparison with existing data sets and climatologies. The diurnal variation of precipitation over the oceans has been mapped with the first 2 years of TRMM data and shows a distinct early morning peak. The utility of precipitation information as input into numerical weather forecasting models for the improvement of weather forecasts, including improving hurricane forecasting, has also been shown using a combination of TRMM and other existing precipitation data.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
	9Y5	Begin the measurement of sea-surface wind speed and direction at a spatial resolution of 25 km resolution over at least 90% of the ice-free global oceans every 2 days. This represents a resolution increase of a factor of 2, and a 15% increase of coverage over previous measurements. Data from this mission will be used to improve short-term weather forecasts.	Green				Target was discontinued after it was achieved. The focus has changed from producing the measurement capability to the use of the measurement.
				0Y10	Develop/improve methods to couple state-of-the-art land surface and sea ice models to a global coupled ocean-atmosphere model and use to predict regional climactic consequences of El Niño or La Niña occurrence in the tropical Pacific. Results of research will be published in open literature and provided to NOAA's National Climate Prediction Center and the U.S. Navy's Fleet Numeric Prediction Center. Ultimate goal: develop a capability to significantly improve the prediction of seasonal-to-interannual climate variations and their regional climate consequences. The main focus is on North America.	Green	New target.
				0Y11	Measure production and radiative properties of aerosols produced by biomass burning in Africa based on SAFARI 2000 (field experiment) and EOS instruments. Includes extensive international participation. This burning is estimated to contribute one-half of global atmospheric aerosols.	Yellow	New target.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
				0Y12	Launch the NASA-CNES JASON-1 mission. This follow-on to TOPEX/Poseidon is to achieve a factor-of-4 improvement in accuracy in measuring ocean basin-scale sea-level variability. This is 1 order of magnitude better than that specified for TOPEX/Poseidon.	Yellow	New target.
				0Y47	Generate the first basin-scale high-resolution estimate of the state of the Pacific Ocean as part of the international GODAE.	Green	New target.
Identify natural hazards, processes, and mitigation strategies.	9Y6	Provide instruments sufficient to create the first digital topographic map of 80% of Earth's land surface between 60°N and 56°S. The SRTM will be launch-ready by the end of FY 1999.	Green				Target was completed in in FY 1999. SRTM was flown in FY 2000 with great success.
	9Y7	Use the GPS array in southern California to monitor crustal deformation on a daily basis with centimeter precision, and initiate installation of the next 100 stations. The data will be archived at JPL and run in models with results given to the California Seismic Safety Commission and FEMA to be used for earthquake warning.	Green	0Y37	Use southern California GPS array data to understand the connection between seismic risk and crustal strain leading to earthquakes.	Green	Data from the SCIGN are currently being used to monitor crustal strain in southern California and assess the vulnerability to earthquakes. The Southern California Earthquake Center provides coordination and management of activities for SCIGN. Data and solutions for site velocities and time series of site positions are available to the research and operational communities via the Internet.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
	9Y8	Data received from GPS receivers in low-Earth orbit will also be used to test improved algorithms for measuring atmosphere temperature. The data will serve as the future prototype for improving short-term weather forecasts globally. The data will be archived at JPL and the results will be published in science literature.	Green				Target was eliminated.
				0Y38	Develop models to use time-varying gravity observations for the first time in space.	Green	New target.
				0Y39	Demonstrate the utility of spaceborne data for floodplain mapping with FEMA.	Green	New target.
				0Y40	Develop an automatic volcano cloud/ash detection algorithm employing EOS data sets for use by the FAA.	Green	New target.
Detect long-term climate change, causes, and impacts.	9Y9	Begin to conduct daily observations of cloud properties such as extent, height, optical thickness, and particle size.	Yellow	0Y13	Complete the collection of satellite data needed for the 17-year cloud climatology being developed under the International Satellite Cloud Climatology Project. Data will be used to improve the understanding and modeling of role of clouds in climate. Data will be available in the Goddard DAAC.	Green	With the launch of Terra in FY 2000, the objectives of the FY 1999 target were met. In addition, the data needed for the 17-year cloud climatology has been collected. The data are improving the understanding and modeling role of clouds in climate.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
	9Y10	Map aerosol formation, distribution, and sinks over the land and oceans.	Yellow	0Y14	Continue the development of the global aerosol climatology data set and analysis of this climatology in climate models. Data will be available in the Goddard DAAC.	Green	The GACP continues to develop the data set and perform the analysis. To date, the GACP has successfully identified the satellite datasets necessary, established the best algorithms for retrieval of aerosol information from the satellite datasets, has 60% of the aerosol produced appropriately recorded and has delivered it to the NASA LaRC DAAC.
	9Y11	Achieve significant reduction in the uncertainty in components of Earth's radiation balance (i.e., improved angular models leading to an estimated error reduction in regional-scale monthly-average net radiation of about 50%).	Yellow	0Y15	Provide for the continuation of the long-term, precise measurement of the total solar irradiance with the launch of EOS ACRIM.	Green	Measurements being continued. ACRIM launched December 1999. Early analysis of data shows that instrument is collecting data with required accuracy/precision. ACRIM solar irradiance data have been compared to earlier satellite instrument data and show consistency with these earlier datasets. New data show clear gains in accuracy/ precision.
				0Y16	Acquire, through a Radarsat repeat of Antarctic Mapping Mission conducted September–October 1997, a second set of high-resolution radar data over all of Antarctica for comparison with baseline data set acquired in 1997, to identify changes on the ice sheet.	Green	New target.
				0Y17	Publish the first detailed estimates of thickening/thinning rates for all major ice drainage basins of Greenland ice sheet, derived from repeated airborne laser-altimetry surveys. Measures represent the baseline data set to compare with early GLAS data (July 2001 launch).	Green	New target.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
				0Y18	Initiate a program of airborne mapping of layers within the Greenland ice sheet to decipher the impact of past climate variation of polar regions.	Green	New target.
				0Y19	Develop a remote-sensing instrument/technique for ocean surface salinity measurements from aircraft. Goal: to improve measurement accuracy to 1 order of magnitude better than available in FY1998. The ultimate goal is the capability to globally measure sea surface salinity from space.	Green	New target.
				0Y20	Continue to improve the design and sophistication of a global climate system model, including use of high resolution, to make it a state-of-the-art climate system model for projecting the climatic consequences at the regional level. Improvement will be manifested in increased resolution from added computing power and better numerical representations.	Green	New target.
Understand the causes of variation in atmospheric ozone concentration and distribution.	9Y12	Use new retrieval methods to collect and analyze three new data products, including surface ultra-violet radiation, tropospheric aerosols, and, in certain regions, tropospheric columns. Together with SBUV/2 data, there will now be a continuous 20-year data set for total ozone that will measure the ultimate effectiveness of the Montreal Protocol on substances that deplete the ozone layer. These data are also useful in routing aircraft around areas of concentrated volcanic dust. These new and extended data products will be made available on the TOMS Web site for dissemination and access to a broader community than just NASA-sponsored scientists.	Green				Target was eliminated.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
	9Y13	Improve the collection and analysis of measurements provided by SAGE II. These improvements include: lunar occultation capability allowing for new nitrogen trioxide (NO_3) and chlorine dioxide (OClO) measurements, additional wavelength sampling providing direct measurements and ability to retrieve aerosols throughout the troposphere, and appreciably higher spectral resolution allowing significantly improved distributions of water vapor and ozone in the upper troposphere and lower stratosphere. This represents approximately a two-thirds reduction in error in near-tropopause water vapor measurements, and extension of ozone measurements into mid-troposphere with 10 to 15% errors. Such data were not available before.	Yellow			Yellow	Target remains yellow due to Russian launch delays. The instrument has been delivered to the Russians and is awaiting launch.
	9Y14	Initiate the full Southern Hemisphere Additional Ozonesonde (SHADOZ) network to obtain the first ever climatology of the upper tropospheric ozone in the tropics.	Green				Target was completed in FY 1999 and was not continued in FY 2000.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
	9Y15	Continue the detailed multi-aircraft study of troposphere chemistry over the tropical Pacific Ocean, especially the contribution of long-range transport of air from South America and Africa to otherwise unpolluted areas. Complete the field measurement phase of PEM-Tropics-B (rainy season) with an improved payload that has resulted from an initiative to develop a smaller, lighter payload with equal or better performance than PEM-Tropics-A (dry season). The results will be fully analyzed and published.	Yellow	0Y23	Complete the analysis and publication of the PEM-Tropics-B field experiment.	Green	PEM-Tropics-B field experiment was completed, and the results for PEM-A have been published. Results for PEM-Tropics-B were prepared for publication and will be published in FY 2001.
				0Y22	Implement the SAGE III Ozone Loss and Validation Experiments. Measurements will be made from October 1999 to March 2000 in the Arctic/high-latitude region from the NASA DC-8, ER-2, and balloon platforms. Will acquire correlative data to validate SAGE III data and assess high-latitude ozone loss.	Green	New target.
	9Y16	Measure surface levels of chlorine- and bromine-containing chemical compounds addressed under the Montreal Protocol to document the decreasing concentrations of the regulated compounds and the rising concentrations of their replacements to quantify the decrease in total halogen abundance in the lower atmosphere. The data will be provided to researchers supporting the World Meterological Organization (WMO) assessment process.	Green				Target completed in FY 1999.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	Rating	FY 1999 00#	Target	FY 2000 Rating	FY 2000 Trend Assessment
				0Y24	Complete the Troposphere Chemistry aircraft instrument size and weight reductions (by ~40%) initiative.	Green	New target.
				0Y25	Complete the planning for major new 2001 airborne/unpiloted aerospace vehicle mission that will use a smaller Troposphere Chemistry aircraft instrument.	Green	New target.
Successfully launch spacecraft.	9Y35	Successfully launch three spacecraft within 10% of budget on average.	Yellow	0Y36	Earth Science will successfully launch three spacecraft and deliver two instruments for international launches within 10% of budget on average.	Green	There were five launches accomplished: TERRA, ACRIM, SRTM, GOES-L, and NOAA-L. Delivered instruments to the following international launches/spacecraft: SAC-C (Argentina), CHAMP (German), METEOR-3M (Russian), Jason (French) and FedSat. The cost growth on average from the FY 2000 President's budget baseline was 7%.
Implement open, distributed, and responsive data system architectures.	9Y17	Make Earth science data on land-surface characteristics, ocean-surface conditions, and climate available to users within 5 days.	Blue	0Y26	EOSDIS will continue to make available data on prediction, land surface, and climate to users within 5 days.	Blue	The median time to distribute EOSDIS data products was 1 day. The average time to distribute data products was less than 4 days. ESE continues to exceed targeted performance.
	9Y18	Increase the volume of data archived by 10% compared to FY 1997 (target = 126 TB).	Blue	0Y27	EOSDIS will double the volume of data archived compared to FY 1998.	Blue	ESE had well over 500 TB of data in the archives at the end of FY 2000 greatly exceeding the goal of 368 TB's. The volume increase is due in part to the new data from Terra satellite and the addition of data from the Federation ESIP 2s. Of the total amount, 440 TB were archived in the V0 systems, over 100 TB were archived in the ECS systems and over 6 TB were archived by the Federation ESIP's.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
	9Y19	Increase the number of distinct customers by 20% compared to FY 1997 (target = 699,000).	Blue	0Y28	EOSDIS will increase the number of distinct customers by 20% compared to FY 1998.	Blue	During FY 2000, more than 1.53 million distinct customers accessed the DAACs and ESIP 2s, exceeding the performance target of 1.29 million users by 20%. This increase was due to the increasing number of users coming to the DAACs for Landsat 7 and Terra information and data products and to the addition of the users from the Federation.
	9Y/20	Increase products delivered from the DAACs by 10% compared to FY 1997 (target = 3,171,000 data products).	Blue	0Y29	EOSDIS will increase products delivered from the DAACs by 10% compared to FY 1998.	Blue	In FY 2000, EOSDIS exceeded the performance target of 4.96 million data products by 80% as the number of data product deliveries surpassed 8.8 million. This success is attributed to the growing interest in ESE information and data products due to the launches of the Terra and Landsat 7 and general awareness of Earth Science and global environmental research.
Increase public understanding of Earth system science through education and outreach.	9Y21	Award 50 new graduate/ education research grants and 20 early career postdoctoral fellowships in Earth Science.	Green	0Y30	Award 50 new graduate student research grants and 20 early career fellowships in Earth Science.	Green	ESE continues to meet this target.
	9Y22	Conduct at least 300 workshops to train teachers in use of Earth Science education projects.	Blue	0Y31	Conduct at least 300 workshops to train teachers in use of ESE education products.	Blue	Training of teachers in the use of ESE education products translates into more students using products and a deeper understanding of the world in which they live. Over 340 workshops were conducted in FY 2000, exceeding the ESE performance goal.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
	9Y23	Increase the number of schools participating in GLOBE to 8,000 from 5,900 in FY 1998, a 35% increase. Increase the number of participating countries to 72 from 70 in FY 1998.	Yellow	0Y32	Increase number of schools participating in GLOBE to 10,500, a 30% increase over FY 1999; increase participating countries to 77 (from 72).	Yellow	The metric of absolute number of schools was evaluated for its effectiveness in helping obtain GLOBE program goals. It was determined a more meaningful focus is on the number of teachers trained together with the number of schools rather than just the number of schools. The reason being the probability of a sustainable, viable, reliable program at a school where only 1 teacher had been trained was lower than at a school where 2 or more teachers were trained. Therefore, GLOBE began to request schools put at least 2 teachers through the training to become a GLOBE school. The result is there has been a decrease in the rate at which new schools have been signed on, but an increase in the number of teachers trained and the number of measurements that are being taken and submitted to the data-base. GLOBE currently has 9,643 participating schools in 94 countries.
Develop and transfer advanced remote-sensing technologies.	9Y28	Demonstrate a new capability to double the calibration quality for moderate-resolution land imagery.	Green				Target eliminated.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
				0Y33	Achieve a 50% reduction in mass for future land imaging instruments.	Blue	New target.
	9Y29	Transfer at least one technology development to a commercial entity for operational use.	Blue	0Y34	Transfer at least one technology development to a commercial entity for operational use.	Green	Targeted performance was achieved but represented a decline from the FY 1999 level. ESE completed 3 technology transfers in FY 1999 and two in FY 2000.
	9Y30	Advance at least 25% of funded instrument technology developments one TRL to enable future science missions and reduce total cost.	Green	0Y35	Advance at least 25% of funded instrument technology development one TRL to enable future science missions and reduce their total cost.	Blue	26 percent of funded technology develop ments increased at, least 1 TRL in FY 1999 and 20 of 27, or 74 percent, of Incubator instruments advanced by 1 or more TRLs in FY 2000, exceeding the target by 49%.
Extend the use of Earth.	9Y31	Establish at least 5 new Regional Earth Science Applications Centers (RESAC).	Blue	0Y41	At least 1 RESAC becomes self-sustaining. Continue funding for the remaining centers.	Yellow	The RESACs are a 3-year funded program that began in March 1999. The program involved the RESACs generating self-sustaining activities in the area of remote-sensing applications or becoming self sustaining in their own right, and being able to accomplish the objectives of such a plan by the end of the program, approximately March 2002. One RESAC has spun off a self-sustaining commercial venture, although none of the 7 RESACs will be self-sustaining themselves as organizations by the end of FY 2000, since they have been operational only 1 year.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
	9Y32	Establish at least 8 new projects with the USDA in the areas of vegetation mapping and monitoring, risk and damage assessment, resources management and precision agriculture.	Blue				Target was eliminated.
	9Y33	Complete solicitation for at least seven cooperative agreements with State and local governments in land use planning, land capability analysis, critical areas management, and water resource management.	Blue				Target was eliminated.
				0Y43	Implement at least five joint applications research projects/ partnerships with State and local governments in remote-sensing applications.	Green	New target.
Support the development of a robust commercial remote-sensing industry.	9Y34	Establish at least 75 commercial partnerships in value-added remote-sensing product development; an increase from 37 (100%) over FY 1997.	Blue				Target eliminated.
				0Y44	Focus EOCAP joint commercial applications research to develop 20 new market commercial products (e.g., oil spill containment software by EarthSat and map sheets products by ERADS, Inc.).	Yellow	New target.
				0Y45	Provide 3 commercial sources of science data (from the data buy) for global change research and applications.	Green	New target.
				0Y46	Develop 2 new validated commercial information products as a result of verification and validation partnerships with industry.	Green	New target.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Make major scientific contributions to national and international environmental assessments.	9Y24	Atmospheric effects of aviation, in collaboration with the FAA. The contributed model results of the climate effects of measured aircraft emissions will be provided to the IPCC.	Green				Target eliminated.
	9Y25	U.S. regional/national assessments in partnership with U.S. Global Climate Research Program (USGCRP) agencies.	Green				Target eliminated.
	9Y26	Make significant contribution to WMO ozone assessment by providing a lead chapter author and most of the global-scale data.	Green				Target eliminated.
	9Y27	Provide a lead chapter author, global scale data, and researchers to the IPCC Assessment Report, sponsored by the United Nations Environment Program and WMO.	Green				Target eliminated.
				0Y48	Sponsor two regional assessment studies of environmental variations and natural resources vulnerability.	Green	New target.
				0Y5	Complete the contribution to the First National Assessment of the Potential Consequences of Climate Variability and Change: provide climate scenario information, support the national synthesis, conduct several regional U.S. analyses, and provide supporting research for sector analyses. Provide information to the U.S. National Assessment Coordination Office.	Green	New target.

EARTH SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
				0Y6	Conduct the first regional international assessment in South Africa. Quantify the effects of climate variability and management practices on the environment, publish in open literature, and provide analyses to IPCC for their 2000 assessment report.	Yellow	New target.
				0Y8	Provide the first global, regional, and country-by country forest cover inventory in support of national and international needs research, operational, and policy communities. Publish and provide to IPCC and the International Geosphere-Biosphere Programme for their 2000 assessment report.	Green	New target.

Human Exploration and Development of Space Enterprise

FY 2000 Human Exploration and Development of Space (HEDS) Enterprise

In FY 2000, NASA and its international partners passed a major test in the assembly of the International Space Station (ISS). The launch and docking of the Russian Service Module "Zvezda" was critical to the ability to proceed forward with the baseline assembly sequence. FY 2000 also included two Space Shuttle flights and the flight of a Russian Progress cargo ship; these missions to the ISS prepared for its first crew ("Expedition 1"). The Expedition 1 crew took up residence in FY 2001. More than 90 percent of the ISS prime contractor's development has been completed and the program has scheduled seven U.S. assembly missions, one Russian assembly mission, two Soyuz flights, and five Progress resupply flights for FY 2001.

There were four successful Space Shuttle missions in FY 2000, accomplishing several important milestones for the Shuttle fleet. STS-103 serviced the Hubble Space Telescope with four extravehicular activity (EVA) days to renew and refurbish the telescope. STS-99 was the Shuttle Radar Topography Mission (SRTM) as part of an international project spearheaded by the National Imagery and Mapping Agency and NASA, with participation from the German Aerospace Center, DLR. Besides contributing to the production of better maps, the SRTM measurements could lead to improved water drainage modeling, more realistic flight simulators, better locations for cell towers, and enhanced navigation safety. STS-101 and STS-106 supported development and assembly of the ISS.

In FY 2000, HEDS/Life and Microgravity Science and Applications funding supported grants to science investigators through six NASA Research Announcements (NRA). The number of science investigations supported increased to 955 investigations, consistent with continuing preparations for the unprecedented availability of orbital research opportunities on the ISS. We completed preparations for research on STS-107, a Space Shuttle mission currently scheduled for launch FY 2002. (STS-107 has been delayed due to safety inspections performed on the Shuttle orbiter *Columbia*.)

Investigators evaluated and developed research plans to evaluate methods for protecting the astronauts' bone, muscle, and physical work capacity in the harsh conditions of space. A treadmill exercise plan, the use of potassium citrate to prevent kidney stones, the use of biphosphonates and resistive exercise regimens to preserve bone, and the use of Midodrine for dizziness and fainting on landing were all studied by investigators.

Life science investigators reported preliminary scientific results from their STS-95 Space Shuttle experiments. This FY 1999 flight included Senator John Glenn as a participant in experiments on aging, and was key to a new cooperative venture with the National Institute of Aging now underway to support a study on balance and equilibrium control. Another Memorandum of Understanding was developed with the National Cancer Institute to explore new approaches to detect, monitor, and treat disease.

Investigators will use biological models to develop smaller, sensitive medical sensors.

A HEDS-supported physicist first demonstrated that it is possible to produce a coherent beam of atoms, which is analogous to a laser beam. He increased the number of atoms in an initial atom beam by using light and a novel state of matter called a Bose-Einstein condensate. The atom laser may replace conventional atom beams where ultimate precision is required, in items such as atomic clocks. Potential application of atom lasers to the field of nano-scale integrated circuits could be very fruitful. A detailed understanding of atomic interactions will lay the foundation for the development of far-reaching technologies for deep space travel and microcircuit design.

During FY 2000, other progress in HEDS included surpassing the goal of reserving 30 percent of Space Shuttle and ISS resources for commercially supported investigations. A necessary precursor to expanding the future commercial utilization of the ISS is the establishment of a pricing policy for the Commercial Demonstration Program. This was accomplished as planned. NASA also entered into two initial commercial agreements to use U.S. resources on the ISS.

Goal: Expand the Space Frontier.

Objective: Enable human exploration through collaborative robotic missions.

In FY 2000, NASA substantially revised its plans for robotic exploration of the surface of Mars. Experiments on a planned 2001 mission will not be flown due to the mission's cancellation. Planning for future robotic missions to Mars is underway. In 2001, the National Research Council will conduct a study to better understand the environmental, chemical, and biological risk posed by human exploration of Mars. The study results will guide the planning for HEDS participation in robotic missions to Mars.

Performance Target: Complete Radiation Research Instrument for the Mars 2001 mission to study transit, orbital, and surface radiation effects and conduct three workshops to define and prioritize research tasks in subjects such as radiation shielding materials, in situ resource utilization, fluids management, and heat transfer technology. Complete the science definition of granular flows, flight and dust management experiments to begin gathering research data to alleviate critical problems of dust buildup, habitat foundation engineering, and rover performance during planetary exploration. **FY 2000 Human Exploration and Development of Space #33 (0H33)**

Earth's magnetic field protects people in low-Earth orbit and below from highly energetic space radiation. While the health effects of this radiation are not fully understood, it is clear that any future plans for human exploration of space must address this issue. By successfully accomplishing the following performance target, we move a step closer to understanding and solving the challenges of space radiation.

Actual Performance: The radiation research instrument was completed, workshops were held, and science definitions of granular flows, and flight and dust management experiments were completed as called for in the target. The design and development of the orbiter instrument has been completed. Due to changes in the Space Science program planning, the Mars 2001 Lander instrument has been eliminated from current plans. NASA will investigate concepts for a unit having a 1 kilogram (kg) mass for future flight in FY 2001.

Target Assessment: Green

Supporting Details

Mars Robotic Flight Investigations:

The MARIE (orbiter) radiation instrument that will be flown on the 2001 orbiter mission was delivered to the spacecraft contractor and has been integrated on the spacecraft. Development of the Lander instrument to measure the radiation environment has been stopped following cancellation of the Lander mission.

The design and development of the orbiter instrument has been completed. The Mars 2001 Lander instrument has been scrubbed from plans. Concepts for a 1 kg unit will be addressed in FY 2001.

Workshops:

Radiation Shielding Workshop held August 8–9, 2000.

Fluids Management and Heat Transfer Technology Workshops held June 25–26 and September 22, 2000.

In situ resource (i.e., Mars surface materials) utilization workshop held on June 5, 2000.

Science Definition:

Granular Flows Experiment Science Concept Review completed June 14, 2000.

Dust Management Experiment Science Concept Review completed June 15, 2000.

Data Sources: Workshop reports/findings, science concepts review panel reports, final reports for Mars 2001 radiation hardware.

Verification/Validation: Collection of reports, review by the Life and Microgravity Sciences and Applications Advisory Committee completed.

Performance Target: Complete the integration and testing of the Mars In-situ Propellant Production Precursor (MIP) flight unit for the 2001 Mars Surveyor mission. **FY 2000 Human Exploration and Development of Space #35 (0H35)**

This activity is an important component of preparation for future exploration of Mars.

Actual Performance: Development of the Mars in situ Propellant Production Precursor (MIP) was completed on schedule; however, this target was not achieved due to the replanning of robotic missions to Mars following the loss of the Mars Polar Lander. Future options for the flight of the Mars in situ Propellant Production Precursor are being considered.

Target Assessment: Red, due to the mission's cancellation.

Data Sources: Cancellation of Mars 2001 Mission—Mars rollout plan October/November 2000.

Verification/Validation: Target not achieved.

Objective: Define innovative, safe, and affordable human exploration mission architectures.

In FY 2000, NASA continued with the definition of potential future human exploration missions through developing a HEDS technology plan and creating a planning team to analyze and development strategies for the next two decades. We also completed preliminary planning to underpin the Administration's proposal to the Congress for funding in FY 2001 for the HEDS Technology/Commercialization Initiative.

Performance Target: Complete the development and initiate the implementation of a comprehensive technology investment strategy to support future human exploration that includes critical capability development for increasing self-sustainability, decreasing transit times, developing commercial opportunities, reducing cost and risk, and increasing knowledge and operational safety. **FY 2000 Human Exploration and Development of Space #36 (0H36)**

This activity will facilitate development of an innovative, safe, and affordable human exploration mission architecture.

Actual Performance: We completed preliminary planning for a FY 2001 HEDS Technology/Commercialization Initiative (HTCI) to address exploration and commercial development of space technology needs. HTCI was included in the FY 2001 President's budget, and detailed program formulation is underway. In addition, the Decadal Planning Team was formed with personnel from each NASA Center and Headquarters, and developed preliminary science-driven, technology-enabled architectures that identified how certain common technical capabilities could be used to achieve a spectrum of future destinations (the Moon, Mars, asteroids, libration point-scientific outposts).

Target Assessment: Green

Data Sources: HTCI Program Formulation Authorization memo signed March 8, 2000; presentations of the Decadal Planning Team.

Verification/Validation: Review of above data sources.

Objective: Invest in enabling high-leverage exploration technologies.

Performance Target: In coordination with other Enterprises, develop and implement tests and demonstrations of capabilities for future human exploration in the areas of advanced space power, advanced space transportation, information and automation systems, and sensors and instruments. **FY 2000 Human Exploration and Development of Space #38 (0H38)**

This activity is an early component of investment in high-leverage exploration technologies.

Actual Performance: Selected low-level investments were made in spacesuits and tools and in developing planetary surface-resource utilization technologies. Limited technology development in support of future human exploration is ongoing, enabling low-level investments in human support, microgravity and radiation effects and countermeasures; research ventures with small businesses in using Mars surface materials to produce propellants, and cross-Enterprise investments in space power and data management.

Target Assessment: Yellow. The timing and level of funding available for this activity resulted in delayed and diminished effort.

Data Sources: Budget allocations for FY 2000 directly applied to HEDS exploration priorities.

Verification/Validation: Budget allocations for FY 2000 directly applied to HEDS exploration priorities.

Goal: Enable and establish a permanent and productive human presence in Earth orbit.

Objective: Provide safe and affordable access to space.

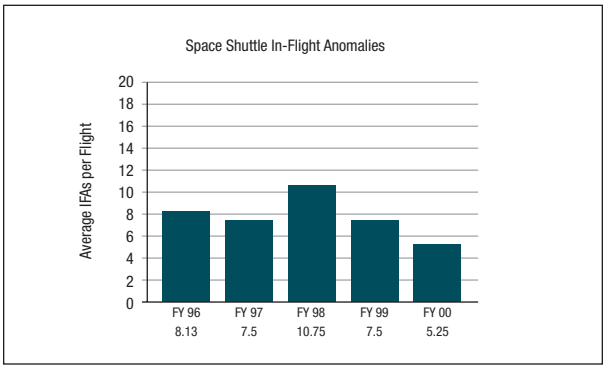
The Space Shuttle program goal is to provide safe, reliable, and affordable access to space. The Shuttle is the only U.S. vehicle that provides human transportation to and from orbit. The priorities of the Space Shuttle program are to: (1) fly safely, (2) meet the flight manifest, (3) improve mission supportability, and (4) continuously improve the system. Effective applications of these priorities has a beneficial impact on the cost-effectiveness of Space Shuttle operations.

Several indicators and trends illustrate the improvement gained toward these program priorities in FY 2000. Workforce safety is reflected by two injury-related statistics: an 80 percent reduction in lost workdays and a 57 percent reduction (since 1992) in lost time cases. This is more remarkable given that this occurred during a period of major workforce reductions (program contractor and program civil service workforce reductions of 38 percent and 50 percent respectively). In addition, safety was maintained while we put into place the Shuttle Flight Operations Contract, a new approach to operations that features a less-invasive mode of Government "insight" into contractor operations from the previous approach of civil service oversight of contractors. We were concerned that the transition would be unsettling and result in increased accidents. The emphasis on safety first and foremost is key to this success.

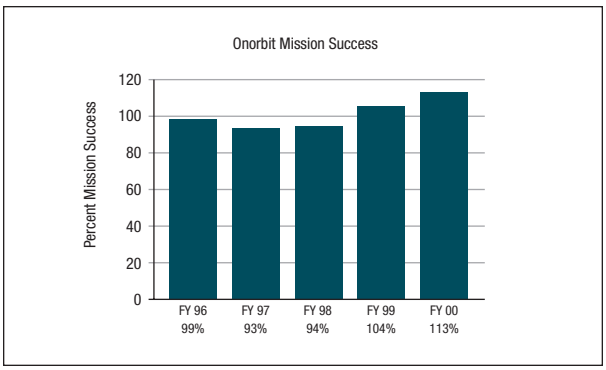
Process improvements, along with hardware and software enhancements, have reduced the risk of the loss of vehicle and crew during ascent—from approximately 1 in 248 to 1 in 438, and have reduced total (ascent/onorbit/descent) mission risk from approximately 1 in 145 to 1 in 245. A program of safety upgrades has been initiated to further reduce these risk assessments. Potentially, if funding is available and the upgrades can be successfully developed and implemented, the risk would drop to about 1 in 995 for ascent and 1 in 420 for total mission risk.

The length of time required to plan a new (or "call-up") mission was greatly reduced, with the STS-103 Hubble Space Telescope servicing mission-planning template requiring only 8 months versus previous mission planning timelines of 12 months. We also track the number of anomalous events during flights. In FY 2000 we averaged approximately 5.25 in-flight anomalies per flight. Five spacewalks (extravehicular activities) were performed during the FY 2000 flights, amounting to almost 13 hours for ISS assembly activities and over 24 hours to repair and service the Hubble Space Telescope.

Performance Target: Have in place an aggressive Shuttle program that ensures the availability of a safe and reliable Shuttle system through the ISS era. **FY 2000 Human Exploration and Development of Space #15 (0H15)**



Space Shuttle In-flight Anomalies.



Onorbit Space Shuttle Mission Success.

This program was initiated to proactively upgrade the Shuttle and keep it flying safely and efficiently to 2012 and beyond to meet Agency commitments and goals for human access to space.

Actual Performance: Accomplishments during FY 2000 included all certification testing on the High-Pressure Fuel Turbopump and continuing project formulation for the following Space Shuttle upgrade candidates: The Electric Auxiliary Power Unit (EAPU), the Space Shuttle Main Engine (SSME) Block III upgrade, the Advanced Health Management System (AHMS) and the Cockpit Avionics Upgrade (CAU). However, expectations were for a higher level of maturity in the formulation and design definition of the individual upgrades.

Target Assessment: Red. The target assessment is red, due to delays in achieving the higher maturity level.

Data Sources: External—Contractor provided data for schedule and technical status reviews.

Verification/Validation: Design Certification Reviews and Authority to Proceed reviews.

Performance Target: Achieve seven or fewer in-flight anomalies (IFAs) on average for missions flown. **FY 2000 Human Exploration and Development of Space #12 (0H12)**

IFAs are a key indicator of the quality of the preflight hardware and software preparations, the ability of the preflight testing process to surface potential performance problems, and the understanding of hardware susceptibility to failure.

Actual Performance: There were four missions in FY 2000. The IFAs experienced are listed below:

STS-103:	6 IFAs
STS-99:	2 IFAs
STS-101:	8 IFAs
STS-106:	5 IFAs

This results in an FY 2000 average of 5.25 IFAs per mission, well within the target threshold of 7.0.

Target Assessment: Green

Data Sources: Program Requirements Control Board Meetings.

Verification/Validation: Program Requirements Control Board Minutes.

Performance Target: Initial target: Achieve 85 percent ontime, successful launches, excluding weather risk. Final target: Achieve 100 percent onorbit mission success. **FY 2000 Human Exploration and Development of Space #13 (0H13)**

The Administrator and the Associate Administrator for Space Flight, along with the Space Shuttle program manager, believed that the initial target might be construed by the contractor and civil service workforce as being willing to accept safety risks in order to launch on-time. The final target emphasizes launching when all systems were thoroughly ready to go. The first and foremost emphasis has to be on launching only when the launch management decision is grounded on full system readiness.

Actual Performance: The results for the four missions in FY 2000 were as follows:

STS-103	100% overall mission success
STS-99	100% mission success
STS-101	100% mission success
STS-106	117% mission success

Mission success is defined as the customer requirements for primary payload onorbit operation, as defined in the Flight Definition Requirements Document. More than 100 percent mission success indicates that the mission success criteria were exceeded.

Initial Target Assessment: No longer applicable.

Data Sources: Meetings between NASA and the United Space Alliance contractor.

Verification/Validation: NASA documentation of contractor performance by the Contracting Officer's Technical Representative and by the Space Shuttle program manager.

Performance Target: Achieve a 12-month flight manifest preparation time. **FY 2000 Human Exploration and Development of Space #14 (0H14)**

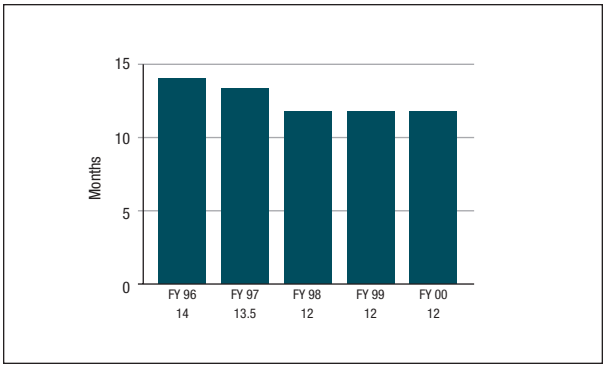
Having a 12-month flight manifest preparation time (template) gives the Space Shuttle program a great deal of flexibility in manifesting for short-notice requirements, as well as giving program customers a good sense of what is required (for lead times) to fly on the Space Shuttle.

Actual Performance: The 12-month template was achieved for the Hubble Space Telescope (HST) repair mission, which was inserted as a new "call-up" mission, due to actual and pending failures of the HST spacecraft attitude control mechanisms (gyros).

Target Assessment: Green.

Data Sources: Meetings between NASA and the United Space Alliance contractor.

Verification/Validation: Contractor provided data and NASA Schedule Review meeting minutes.



Flight manifest preparation time.

Objective: Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.

The ISS made excellent progress during FY 2000. The Unity Node, the Zarya Functional Cargo Block, the Zvezda Service Module, and a Progress cargo ship are flying and operating normally as the cornerstone of what will be a world-class orbiting laboratory, a landmark in international cooperation. The launch and docking of the Service Module in the summer of 2000 was a critical success. With it, Russia has delivered more infrastructure and capabilities to orbit than any other U.S. partner will deliver by completion of assembly. Russia followed the Service Module launch with the successful deployment of the first Progress resupply mission delivering propellant and approximately 1,100 pounds of dry cargo. Outfitting of the ISS via the U.S. Shuttle also continued in 2000. In May on STS-101 and in September on STS-106, the crew transferred several tons of equipment and supplies to the orbiting outpost and performed various tasks for the health and safety of future crews. At the close of FY 2000, the Zarya and Unity were approaching two years of service, with most onorbit systems operating at or above design specifications. The United States and Russia continued to demonstrate an excellent level of cooperation in mission management responsibilities.

In addition to the modules on orbit, more than 90 percent of the prime contractor's development work has been completed, with U.S. flight hardware for the missions through flight 12A already at the Kennedy Space Center (KSC), undergoing integrated testing and launch preparation. The

Canadian-built Space Station Remote Manipulator System (SSRMS) and three Italian-built Multipurpose Logistics Modules have also been delivered to KSC. The program completed the first phase of the Multi-Element Integrated Test (MEIT) with ISS elements successfully demonstrating overall hardware and software compatibility. The first assembly flight of FY 2001, Flight 3A, delivered and integrated the Z1 Truss, Control Moment Gyros, and PMA-3 with the onorbit vehicle. That led to the first three-person, permanent human presence aboard the ISS when the Expedition 1 crew was launched via Soyuz on Flight 2R. In late 2000, ISS Flight 4A provided the ISS with an additional 19 kilowatts of renewable electric power with delivery of the photovoltaic arrays, batteries, and thermal radiators.

ISS assembly activity will greatly accelerate over the next year. During FY 2001, the program has scheduled seven U.S. assembly missions, one Russian assembly mission, two Soyuz flights, and five Progress resupply flights. Microgravity and biomedical research capabilities became available with the launch of the U.S. Laboratory in February 2001. Another partner, Canada, will join the United States and Russia in having operational elements onorbit through the launch of the Canadian robotic arm and SSRMS.

Although tremendous progress was made during FY 2000, several ongoing issues continued to constrain the program and prevent achievement of the FY 2000 Performance Targets. The Russian Proton failures and Service Module launch schedule delayed the entire Assembly Sequence into FY 2001. With the launch of the Service Module in July 2000, the program has initiated an aggressive plan to launch 15 missions during FY 2001. Outyear ISS contingency planning included plans to augment Russian propulsion and logistics capabilities with the Space Shuttle, use of the Interim Control Module in the event of Service Module failure, and development of a permanent U.S. propulsion module. Early design, schedule, and cost issues with the U.S. propulsion module dictated a reassessment of the entire project. A new design approach has been selected, and a formal decision to proceed will be reviewed in the spring of 2001.

Performance Target: Deploy and activate the U.S. Laboratory Module to provide a permanent onorbit laboratory capability. **FY 2000 Human Exploration and Development of Space #16 (0H16)**

The aluminum U.S. Laboratory Module is 28 feet long and 14 feet in diameter.

This activity is a critical element of advancing scientific objectives aboard the International Space Station, since the Laboratory Module serves as the "nerve center" for controlling the ISS and provides the laboratory rack space used for holding the research facilities needed to conduct experiments.

Actual Performance: The revised Assembly Sequence delayed the Laboratory Module flight from FY 2000 until February 2001. During this delay, the lab continued to make significant progress in MEIT testing and Shuttle integration.

Target Assessment: Yellow. The lab was not launched during FY 2000 as planned due to the Russian Service Module delays. However, the launch preparations' progress was significant and launch and activation occurred in February 2001.

Data Sources: The ISS Revision F Assembly Sequence dated August 24, 2000, and the weekly "Felicity" status report.

Verification/Validation: The Performance Target status information is documented in the weekly "Felicity" status report. This status report is reviewed and verified weekly by the ISS program manager and development team. The weekly status charts and schedules charts are available on the ISS program Web sites.

Performance Target: Conduct operations with a three-person human presence on the ISS. **FY 2000 Human Exploration and Development of Space #61 (0H61)**

Three-person operations are essential for advancing scientific, exploration, engineering, and commercial objectives on the ISS.

Actual Performance: The revised Assembly Sequence delayed delivery of the first Expedition crew to the ISS. The crew continued training and began their stay on orbit in late October 2000. During FY 2001, the three-person crew will conduct permanent onorbit operations and research, as well as host a number of Shuttle, Progress, and Soyuz visits.

Target Assessment: Yellow. The three-person human presence was not initiated during FY 2000 as planned; however, progress was significant, and launch of the first crew occurred in October 2000.

Data Sources: The ISS Revision F Assembly Sequence dated August 24, 2000, and the weekly "Felicity" status report.

Verification/Validation: The Performance Target status information is documented in the weekly "Felicity" status report. This status report is reviewed and verified weekly by the ISS program manager and development team. The weekly status charts and schedules charts are available on the ISS program Web sites.

Performance Target: Deliver to orbit the first of three Italian-built Multipurpose Logistics Modules (MPLM), built by the Italian Space Agency, to provide a reusable capability for delivering payload and systems racks to orbit. **FY 2000 Human Exploration and Development of Space #19 (0H19)**

A reusable capability for delivering scientific and systems racks to orbit is essential for cost-effective ISS operations.

Actual Performance: The revised Assembly Sequence delayed launch of the MPLM until March 2001. All three MPLM have been delivered to KSC. During the launch delay, the MPLM continued final testing and checkout.

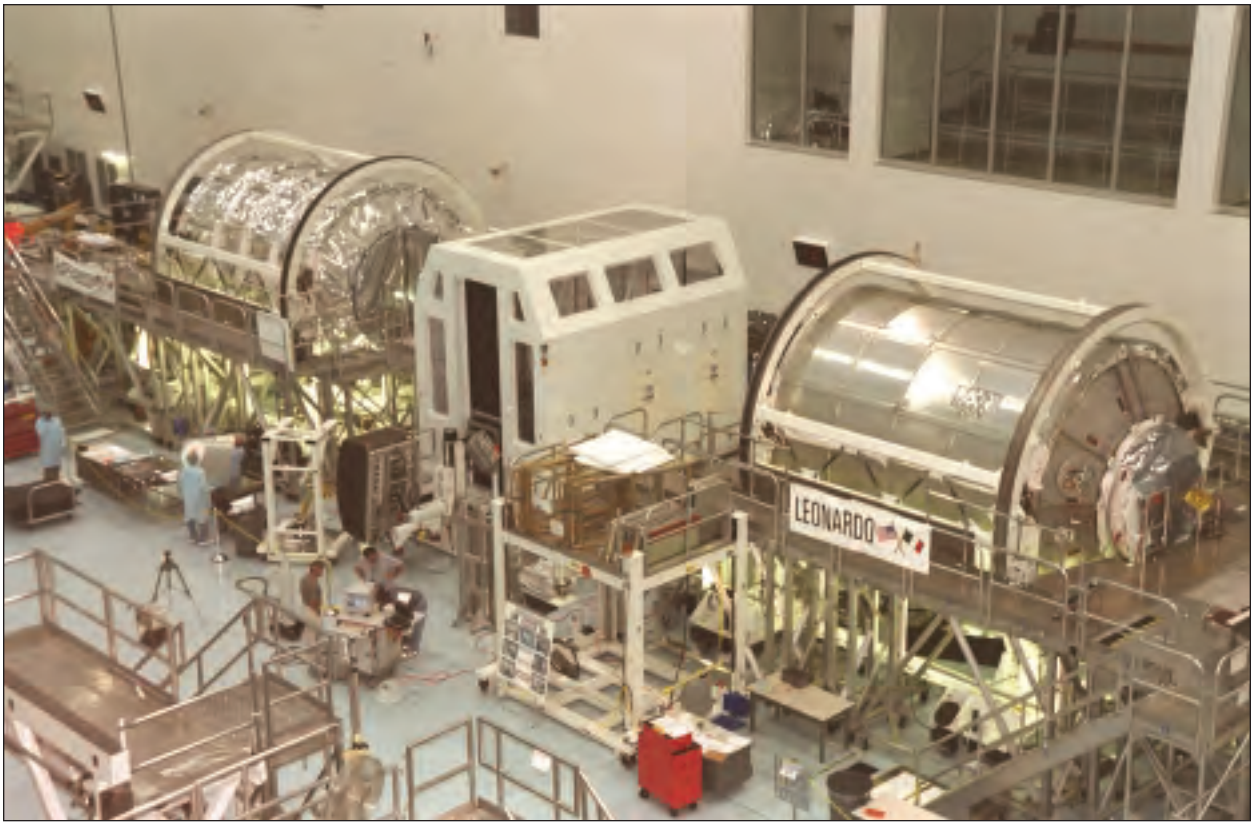
The ISS Expedition 1 crew takes a break from training to pose for a crew photo. From the left are cosmonaut Sergei Krikalev, flight engineer; astronaut William Shepherd, mission commander; and cosmonaut Yuri Gidzenko, Soyuz commander.

Target Assessment: Yellow. The first MPLM was not delivered to orbit during FY 2000 as planned; however, progress was significant and the first launch to deliver payloads and systems racks occurred in March 2001.

Data Sources: The ISS Revision F Assembly Sequence dated August 24, 2000 and the weekly "Felicity" status report.

Verification/Validation: The Performance Target status information is documented in the weekly "Felicity" status report. This status report is reviewed and verified weekly by the ISS program manager and development team. The weekly status charts and schedules charts are available on the ISS program Web sites.

Performance Target: Deploy and activate the Canadian-built Space Station Remote Manipulator System (SSRMS) to



In the Space Station Processing Facility sit Leonardo (right) and Raffaello (left), two Multipurpose Logistics Modules (MPLMs) built by Italy for the International Space Station.

provide an ISS-based remote manipulating capability for maintenance and assembly. **FY 2000 Human Exploration and Development of Space #17 (0H17)**

This element is an important part of ISS assembly and operations, since it enables the grappling and positioning of hardware elements on the ISS, and the SSRMS cameras provide a viewing capability for supporting maintenance activities.

Actual Performance: The revised Assembly Sequence delayed launch of the SSRMS until April 2001. The SSRMS is at KSC and was successfully integrated with other hardware and software elements during the MEIT program. It has been integrated into the Spacelab Pallet and was turned over for Shuttle integration in February 2001.

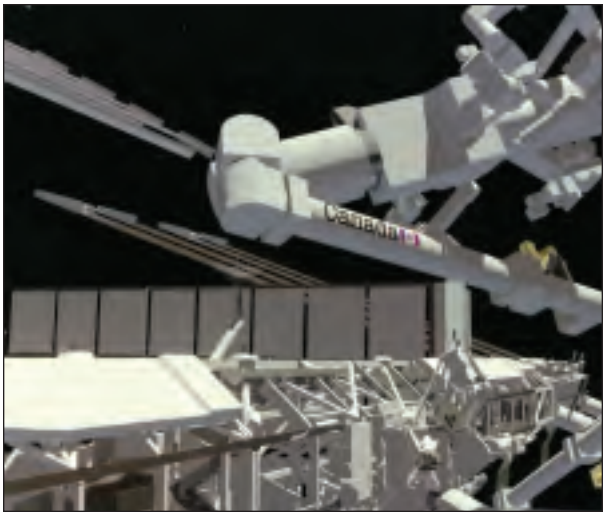
Target Assessment: Yellow. The SSRMS was not delivered to orbit in FY 2000; however, progress was significant and deployment and activation is expected in mid-2001.

Data Sources: The ISS Revision F Assembly Sequence dated August 24, 2000, and the weekly "Felicity" status report.

Verification/Validation: The Performance Target status information is documented in the weekly "Felicity" status report. This status report is reviewed and verified weekly by the ISS program manager and development team. The weekly status charts and schedules charts are available on the ISS program Web sites.

Performance Target: Deploy and activate the Airlock to provide an ISS-based EVA capability. **FY 2000 Human Exploration and Development of Space #18 (0H18)**

The U.S. Airlock enables the ISS crew to conduct space-suited operations using either the Russian Orlan suit or the U.S. suit. The ability to conduct such operations is critical to the maintenance, assembly, and operations of the ISS.



This artist's concept depicts the Canadian Space Station Remote Manipulator System (SSRMS) mechanical arm aboard the International Space Station (ISS).

Airlock Module.

Actual Performance: The revised Assembly Sequence delayed launch of the Airlock until May 2001. The Airlock completed internal outfitting and testing at the manufacturing site. It arrived at KSC in September 2000. Launch site processing is ongoing. The Airlock is scheduled for turnover for Shuttle integration in March 2001.

Target Assessment: Yellow. The Airlock was not delivered to orbit in FY 2000; however, progress was significant and deployment and activation is expected in mid-2001.

Data Sources: The ISS Revision F Assembly Sequence dated August 24, 2000 and the weekly "Felicity" status report.

Verification/Validation: The Performance Target status information is documented in the weekly "Felicity" status report. This status report is reviewed and verified weekly by the ISS program manager and development team. The weekly status charts and schedules charts are available on the ISS program Web sites.

Performance Target: Complete preparations for the initial ISS research capability through integration of the first rack of the Human Research Facility (HRF-1), five EXPRESS Racks (ER) with small payload research, and the Microgravity Science Glovebox (MSG). **FY 2000 Human Exploration and Development of Space #20 (0H20)**

Preparations for the initial ISS research operations represent a statement as to the readiness of the U.S. research community to begin providing a return on the public's investment in the ISS.

Actual Performance: Target partially achieved: Rack integration and launch have slipped to the right with the Assembly Sequence. The revised Assembly Sequence delayed launch of the first research racks until March and April 2001. Rack Fabrication/Assembly/Testing/Integration have continued. The HRF, ER 1 and several subrack payloads have completed final integrated testing at KSC and are proceeding through flight processing in support of launch in March and April 2001. ER 2 was delivered to KSC in September 2000 in support of launch in April 2001. ERs 4 and 5 were delivered to KSC in early January 2001 in support of launch in June 2001. The MSG has been remanifested to a later flight and is scheduled to launch in October 2001.

Target Assessment: Yellow. The first seven research racks did not complete integration in FY 2000, however progress was significant and integration is expected to be completed during FY 2001. The HRF was launched to the ISS in March 2001.

Data Sources: The Payloads Office weekly and monthly status reports to the ISS program manager. The ISS Revision F Assembly Sequence dated August 24, 2000, and the weekly "Felicity" status report.

The X-38 second prototype glides to a landing over the lakebed at the end of its fifth flight at Edwards Air Force Base, California.

Verification/Validation: The Performance Target status information is documented in the weekly and monthly Payloads Office reports and the "Felicity" status report. This status reports are reviewed and verified weekly by the ISS program manager and development team. The weekly status charts and schedules charts are available on the ISS program Web sites.

Performance Target: Complete the production of the X-38 first space flight test article in preparation for a Shuttle test flight in 2001. **FY 2000 Human Exploration and Development of Space #22 (0H22)**

The X-38 is a prototype for a potential U.S. crew return capability from the ISS in case of an emergency. The investment in rapid prototyping should significantly reduce the costs of constructing a crew return vehicle.

Actual Performance: Budget reductions in FY 2000 and FY 2001 have caused the X-38 Shuttle test flight to move from September 2001 to mid-2002. The production of the test flight article will be completed within FY 2001. The X-38 project continues its pre space flight-concept validation testing through atmospheric vehicle and parafoil flight tests with a high success rate. The first of two 80 percent scale atmospheric vehicles were modified this year to match the space flight vehicle body shape and has completed a captive-carry test attached to the wing of a B-52. This vehicle underwent its first free-flight test in November 2000, using a space flight vehicle full-scale 7,500-square-foot parafoil to land.

Target Assessment: Yellow. The X-38 space flight test article was not completed in FY 2000, however, progress was significant and the test article is expected to be completed in FY 2001.

Data Sources: The ISS Revision F Assembly Sequence dated August 24, 2000, and the weekly and monthly CRV Project status reports.

Verification/Validation: The Performance Target status information is documented in the weekly and monthly CRV Project status report. This status report is reviewed and verified weekly by the ISS program manager and his development team. The weekly status charts and schedules charts are available on the ISS program Web sites.

Objective: Meet strategic space mission operations needs while reducing costs and increasing standardization and interoperability.

Performance Target: Promote privatization of Space Shuttle operations and reduce civil service resource requirements for operations by 20 percent (from the FY 1996 FTE levels) in FY 2000. **FY 2000 Human Exploration and Development of Space #39 (0H39)**

Several external advisory panels examined impacts from the civil service staffing reductions already accomplished and planned in FY 2000 and subsequent years. They recommended a reversal of previous plans and stabilization of staffing levels to avoid the inadvertent compromise of Shuttle safety.

Actual Performance: Although civil service attrition continued until new hires could be put into place, the progress on this target was not tracked, following NASA's decision to hire additional staff to assure that safety would not be compromised for Space Shuttle missions.

Target Assessment: Red

Data Sources: N/A

Performance Target: Promote privatization and commercialization of Space Shuttle payload operations through the transition of payload management functions (payload integration managers, payload officers, etc.) by FY 2000. **FY 2000 Human Exploration and Development of Space #40 (0H40)**

Consistent with National Space Policy, NASA embarked on the steps that would lead to increased privatization and commercialization.

Actual Performance: This action was taken as a preparatory step towards the time when United Space Alliance (USA) would be allowed to obtain their own commercial customers for Space Shuttle flights. The target was to transition approximately one-third of these jobs to USA (under the Space Flight Operations Contract). This was accomplished in FY 2000.

Target Assessment: Green.

Data Sources: Meeting reports and minutes.

Verification/Validation: NASA Budget reviews.

Performance Target: Within policy limitations and appropriate waivers, pursue the commercial marketing of Space Shuttle payloads by working to allow the Space Flight Operations Contractor to target two reimbursable flights, one in FY 2001 and one in FY 2002. **FY 2000 Human Exploration and Development of Space #41 (0H41)**

This activity was initiated to assess the potential market and customer response to commercialization of the Space Shuttle; however, to date it is uncertain whether or not policy restrictions would be lifted so that USA could target these flights.

Actual Performance: It remains feasible, but no reimbursable flights in FY 2001 and FY 2002 are planned.

Target Assessment: Not applicable, due to policy limitations impeding the marketing process.

Data Sources: Letters and meetings.

Verification/Validation: Associate Administrator of Space Flight letter of direction to the United Space Alliance contractor.

Space Operations: NASA's ground and space networks successfully supported all NASA flight missions and numerous other U.S. Government agency, commercial, and international missions. Highlights included: (1) support to the Compton Gamma Ray Observatory spacecraft re-entry, (2) retirement of the Advanced Communications Technology Satellite to the gravity well, (3) support to the Tracking and Data Relay Satellite (TDRS)-8 spacecraft launch in June 2000, and (4) continuous coverage to the Ulysses mission during a project-declared spacecraft emergency. The program also successfully supported all Space Shuttle missions, and the ISS program, including the Service Module docking phase in July 2000. Overall, the networks provided data delivery for all customers in excess of 98 percent.

The Consolidated Space Operations Contract (CSOC) successfully completed a full year of operational support, with performance levels that met or exceeded all contract metric standards. Other significant activities included installation of initial 70-meter, X-band uplink capability at the Goldstone Deep Space Communications Complex; construction and testing of the mono-pulse pointing system for the Cassini radio science experiment; and commercial off-the-shelf software infusion for the Flight Dynamics Facility at Goddard Space Flight Center.

Initial acquisition of commercial ground network services is well underway. Contracts have been established with Getronics to provide wide-area network telecommunications services, and Datalynx, Inc. for EOS support, and Universal Space Network, Inc. to support the Triana project. In addition, NASA is pursuing an Indefinite Delivery/Indefinite Quantity contract with CSOC to supply communications services for NASA's routine, low-Earth orbiting missions.

Performance Target: Reduce space communications budget submit for FY 2000 by 30 to 35 percent from the FY 1996 Congressional budget submit. **FY 2000 Human Exploration and Development of Space #43 (0H43)**

More effective utilization of technology and new operational procedures enable a reduction in the cost of conducting operations while maintaining a high level of operational effectiveness.

Actual Performance: Space Communications budget authority has been reduced by 36 percent, compared to the FY 1996 Budget.

Target Assessment: Green

Data Sources: Relevant budget submits.

Verification/Validation: Compare budget submits.

Performance Target: Increase the expenditures for commercial services to 10 percent of the total space communications budget by FY 2000. **FY 2000 Human Exploration and Development of Space #42 (0H42)**

This activity provides an integrated architecture that could improve efficiency and allow the Government to adopt private sector commercial practices and services.

Actual Performance: FY 2000 commercial expenditures amounted to approximately $51 million, or more than 10 percent of the total budget. NASA's wide-area network backbone was fully commercialized.

Target Assessment: Green

Data Sources: Relevant budget submits at the Center level.

Verification/Validation: Compare budget submits, Space Operations Management Office (SOMO) Commercialization Plan metrics.

Audit Findings/Recommendations/ High Risk Areas for Goal 2

FY 2000 General Accounting Office (GAO) and Inspector General (IG) reports identified ISS concerns related to prime contract changes, Russian compliance with safety requirements, X-38/Crew Return Vehicle project management, and contractor cost overruns and cost control.

The GAO Report, *Space Station: Prime Contract Changes*, identified issues with the growing costs of the ISS program and NASA's efforts to control them, the number of contract changes, and the negotiated costs of change work. NASA management is in general agreement with the content and data in the report. NASA commented that the number and total value of undefinitized contract changes to the original ISS contract has been steadily declining over the past three years. NASA also anticipates having many urgent changes as the ISS program continues and assures that all contract changes will continue to receive management attention.

The GAO Report, *Space Station: Russian-Built Zarya and Service Module Compliance With Safety Requirements,* provided information on Russian compliance with ISS safety requirements, waivers of safety requirements, and whether NASA was due compensation from the Zarya contractor for items that did not meet safety requirements or had performance problems. NASA management concurred with the information in the report. NASA emphasized that flight safety is the Agency's number one goal and that ISS modules will only fly if they are judged to have an acceptable level of risk. NASA expressed concern that the report did not adequately characterize the rigor of the safety review process and lacked sufficient detail for the reader to appreciate all the factors that influence decisions to grant safety waivers.

The IG Report, *X-38/Crew Return Vehicle Project Management*, identified issues with the acquisition strategy and optimistic schedule vs. the greater emphasis on risk and performance management. NASA management concurred with the recommendations and has developed entry/exit criteria for progressing through major project phases to assure that technical, schedule, and cost goals will be met.

The IG Report, *Performance Management of the ISS Contract*, identified concerns with Boeing contract-performance management, cost overruns, and Boeing reorganization indirect cost rate increases. NASA management concurred or partially concurred with the findings and recommendations. NASA agreed to conduct regular performance and cost reviews and definitized the cost overrun proposals through a contract modification. NASA management also agreed to work more closely with the Defense Contract Management Command (DCMC) to monitor Boeing's performance on reorganization activities that could affect the program on an ongoing basis.

Goal: Expand scientific knowledge.

Objective: In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems.

Throughout most of history, we have viewed gravity as an inescapable constant. Gravity has also profoundly affected how humans evolved as physical beings. But new access to the space environment is now allowing scientists to conduct unprecedented research in low gravity, opening a new window on longstanding questions of science and technology. Researchers take advantage of this opportunity to conduct experiments that are impossible on Earth. For example, most combustion processes on Earth are dominated by the fact that hot gases rise. In space, this is not the case, and hidden properties of combustion emerge. Results from this research promise to improve fire safety, fuel efficiency, and pollution control. Materials scientists will study the role of gravity in important industrial processes. Their results may lead not only to the formation of new materials not found on Earth, but to better control of Earth-based processes to obtain improved products. Physicists will take advantage of microgravity to study exotic forms of matter that are better handled in space. Biological research will investigate the role of gravity in life processes. The Enterprise will conduct research to integrate our understanding of the role of gravity on the evolution, development, and function of living organisms and on basic biological processes.

In FY 2000, we continued to develop a robust scientific community to maximize return from future flight opportunities including the ISS. We made awards under 6 NASA Research Announcements (NRA) in FY 2000 and built the investigator community to 955 investigations. All scientific research within HEDS is selected through an open and competitive peer-review process. The health of our research community is indicated by strong responses to NRAs, leading to selection rates of about 20 percent of proposals received. Our researchers published over 1,400 articles in peer-reviewed journals in FY 1999, with similar publication rates expected for FY 2000. We completed preparations for research on STS-107, currently scheduled for launch in FY 2002.

HEDS executed a new memorandum of understanding with the National Cancer Institute of the National Institutes of Health (NIH), focusing on new approaches to detect, monitor, and treat disease. This cutting-edge effort uses biological models to develop medical sensors that will be smaller, more sensitive, and more specific than today's state of the art. The new agreement builds on a strong, existing relationship between NASA and NIH.

While preparations for the next dedicated research mission were completed, NASA's ground-based research continued to provide important results:

- Research implicates elevated levels of nitric oxide in decreased blood-vessel contraction. This research may lead to methods for improving astronauts' ability to stand upon return to Earth, an important safety issue.
- Investigators have demonstrated that muscle healing is inhibited by a period of simulated microgravity before injury. This research has important implications for medical care onorbit and may provide basic insights into the muscle healing process.
- Investigators have identified a key gene in the regulation of plant growth and the response of plants to gravity. This fundamental research could lead to improved plant varieties in space and on Earth.
- Research shows a parathyroid hormone modulates the response of bone-building cells to mechanical stimulation. These findings combined with further research on exercise will help NASA to develop medical protocols for controlling bone loss and muscle atrophy in space. At the same time, this research will contribute to understanding medical problems on Earth.
- A HEDS-supported researcher first demonstrated that it is possible to "amplify" a beam of atoms and create a kind of "matter laser." He has increased the number of atoms in an initial atom beam by using light and a Bose-Einstein condensate. (Published in *Nature,* Dec. 9, 1999.) In the long term, this basic research in quantum mechanics could lead to improved information and telecommunications technology.
- Researchers fabricated single-wall carbon nanotubes, using flame synthesis in normal gravity. Carbon nanotubes are a newly discovered form of carbon (other forms of carbon are charcoal, graphite, and diamond). Nanotubes have very valuable structural and electron-

ic properties, but are expensive to produce in large quantities. Flame synthesis may represent a solution to the production challenge.

Performance Target: Support an expanded research program of approximately 935 investigations, an increase of ~17 percent over FY 1999. Publish 100 percent of science research progress in the annual Life Sciences and Microgravity Research Program Task Bibliographies and make this available on the Internet. **FY 2000 Human Exploration and Development of Space #1 (0H1)**

Budgetary and flight hardware resources are essential for the execution of our mission; however, no resource is more central to the pursuit of NASA's goals than the community of intramural and extramural investigators who propose, conduct, and publish results from research investigations. NASA has worked to develop and support an appropriately sized and outstandingly qualified community of researchers ready to ensure maximum research return from available ISS resources. By achieving this target, we remain on track to maintain and develop an outstanding research community for biological and physical research.

Actual Performance: HEDS supported 955 investigations in FY 2000. The annual Life Sciences and Microgravity Research Program Task Bibliographies were published and are available on the Internet. This document covers FY 1999 investigations.

Target Assessment: Green

Data Sources: Investigations spreadsheets; online bibliographies.

Verification/Validation: Line-by-line review of investigation spreadsheets.

Program and task bibliographies available at *http://peer1.idi.usra.edu/peer_review/taskbook/taskbook.html*

Performance Target: Using suborbital rockets, complete one combustion experiment on the flame spread of liquid fuels to better control Earth/space-based fire hazards, and conduct one investigation to test theories of fundamental physics properties and physical laws of fluids to provide key data for Earth and space-based processing materials. Report the results. **FY 2000 Human Exploration and Development of Space #11 (0H11)**

The experiment will examine the phenomena of flame spreading across a liquid fuel in low gravity to improve models of the burning process here on Earth.

Actual Performance: The combustion-sounding rocket was delayed into FY 2001 due to software integration issues.

The fluid physics sounding rocket flew successfully on July 6, 2000. However, a significant subsystem failure prevented the experiment from running successfully.

Target Assessment: Red

Data Sources: Direct communication with combustion projects branch manager at Glenn Research Center on sounding rocket schedule; Flight Report on the fluid physics experiment: "Extensional Rheology Flight Report."

Verification/Validation: Review of Extensional Rheology Flight Report.

Performance Target: Complete data reduction from the STS-95 Research Module mission. Begin to explore new cooperative efforts with NIH in the area of aging and transfer space-derived research for industry development of a new drug to treat Chagas disease. **FY 2000 Human Exploration and Development of Space #9 (0H9)**

Actual Performance: STS-95 was a nine-day Space Shuttle mission with seven crewmembers, including the historic return to space of Senator John Glenn. STS-95 provided an important flight opportunity for a range of life sciences, physical sciences, and commercial research payloads. This multidiscipline array of research is representative of the research scope projected for the ISS. STS-95 investigations were conducted early in FY 1999; data reduction, interpretation, and publication of results continued throughout FY 2000.

Biomedical research included assessments of the effects that microgravity has on sleep, balance, immune system

changes, bone, muscle, the body's metabolic rate, and cardiovascular processes. Many of the effects of space flight parallel the aging process, and Senator Glenn's participation in these medical studies added age as a variable to the experiments. In addition to the flight research, the National Institute on Aging's (NIA) Baltimore Longitudinal Study of Aging (BLSA) and NASA are collaborating on a ground-based study of balance using the STS-95 research protocol and technology. This study will provide a database for comparing changes in balance in individuals as they age to changes in balance caused by space flight.

Fundamental biology experiments were also carried out on STS-95. These experiments included the study of how exposure to the space environment affects cartilage cell growth, the growth and development of plants, and the response of the nervous system to changes in gravity.

In a collaborative effort with Brazilian researchers, STS-95 produced new data on Chagas disease. Chagas disease is a fatal, insect-borne disease that affects the human nervous and cardiovascular systems. There is no known cure. Some 15 million people are infected, principally in Central and South America.

Supporting Details:

Data reduction: STS-95 data reduction completed. Human Life Sciences data analyses were completed. Microgravity Glovebox experiments final reports/analysis are complete.

The 11 Human Life Sciences investigators presented the preliminary results of their investigations at the public STS-95 conference at NIH in Bethesda, Maryland, in January 2000, in which Senator Glenn participated.

Cooperative Efforts with NIH: A manuscript on the initial findings of a joint NASA/NIA study on the balance system has been submitted to the New England Journal of Medicine. NASA is continuing a study entitled, "Age Associated Differences in Postural Equilibrium Control: Implications for Space Flight." This is a joint NASA/NIA effort at the Baltimore Longitudinal Study on Aging (BLSA), Johns Hopkins Bayview Medical Center, Baltimore. This is a ground-based control study designed to: 1) improve interpretation of STS-95 data, and 2) expand the repertoire of objective measures performed at BLSA to include sensorymotor control of balance.

Chagas Disease Research: Nine proteins included in the STS-95 crystal growth experiments were flown in collaboration with a group of Brazilian crystallographers under the auspices of the Brazilian National Institute of Space Research (INPE). Many of these projects are targets for the development of drugs to treat indigenous South American diseases, including Chagas disease.

All data concerning the experimental projects flown on STS-95 have been returned to the companies or academic institutions sponsoring the projects. All data concerning Chagas disease-related projects flown on STS-95 (including the microgravity-grown crystals and excess protein solution) have been returned to the companies or academic institutions sponsoring the projects.

Target Assessment: Green

Data Sources:

- STS-95 conference at NIH in Bethesda, Maryland, in January 2000
- Manuscript on the initial findings of a joint NASA/NIA study
- Glovebox Investigation Final Reports and associated publications
- Sadhal, S.S., "Applications of Heat Transfer in Equipment, Systems, and Education." Co-Editor on ASME HTD Vol. 361-3/PID vol. 3, 1998, ISBN 0-7918-1597-8
- Trinh, E.H., S.K. Chung, and S.S. Sadhal, "Earth-Based and Microgravity Studies of Spot-Heated Levitated Single Drops." Engineering Foundation Conference on Microgravity Fluid Physics and Heat Transfer, Oahu, Hawaii, September 19–24, 1999
- Cheng, Z., P.M. Chaikin, W.B. Russel, and W.V. Meyer, "Microgravity CDOT-2 Experiment Results." APS March Meeting (March 22), Atlanta, Georgia, 1999
- Protein Crystal Growth Experiments Final Report

Verification/Validation: Review of above data sources.

Goal: Enable and establish a permanent and productive human presence in Earth orbit.

Objective: Ensure and enhance the health, safety, and performance of humans in space.

Space flight exposes humans to low gravity conditions for the first time in evolutionary history and poses major challenges to virtually every system of the body. Beyond the atmosphere and outside Earth's protective magnetic field, space travelers encounter a unique and hostile radiation environment. If humans are to exploit the opportunities of space flight, we must find ways to protect ourselves from hazards unprecedented in the history of human evolution. HEDS conducts interdisciplinary fundamental and applied research to address these challenges.

We made significant progress toward developing advanced new life support technologies and improved approaches for maintaining health in the hostile environment of space. Researchers produced the next generation of tuneable diode lasers and continued testing of an advanced miniature mass spectrometer for monitoring spacecraft atmospheres. These technologies will allow us to monitor contaminants in multiple locations, while reducing power requirements.

Ground-based research designed to simulate space flight demonstrated that the clinically approved drug Midodrine prevented orthostatic intolerance (fainting upon return to gravity). Our research implicated elevated levels of nitric oxide in decreased blood vessel contraction that suggests a new approach for correcting blood pressure control problems associated with space flight and the return to gravity.

Performance Target: Develop medical protocols and test the capability of the Crew Health Care System (CHeCS) as integrated in the ISS U.S. laboratory. **FY 2000 Human Exploration and Development of Space #26 (0H26)**

The Crew Health Care System is a vital component of the ISS for supporting crew health and the continued development of the ISS. Testing of CHeCS hardware moves us one step closer to full research operations.

Actual Performance: Medical protocols have been developed and all initial CHeCS hardware designated to support the Expedition 1 Space Station crew have successfully completed testing for onorbit power, data, and mechanical interface for use in the U.S. lab.

Supporting Details: Equipment for the Crew Medical System that has been fully tested includes a treadmill with vibration isolation system, an interim resistive exercise device system, a blood pressure/electrocardiogram monitor, heart rate monitors, and a medical equipment computer.

Equipment for the Environmental Health System that has been fully tested includes various items of microbiology, radiation, and toxicology hardware. Fully tested equipment includes a grab sample container, a formaldehyde monitoring kit, an acoustic countermeasures, a water sampler and archiver, a water microbiology kit, a surface sampler kit, a solid sorbent air sampler, a tissue equivalent proportional counter, an intravehicular charged particle directional spectrometer, a passive dosimetry system (including crew passive dosimeter on Flight 2R), compound specific analyzer-combustion products, and the audio dosimeter.

Equipment for the Health Maintenance System that has been fully tested includes an ambulatory medical pack, a crew contaminant protections kit, and the advanced life support pack.

Medical protocols have been developed, incorporated into the crew checklist, and used in simulations and procedures during training. Plans for environmental monitoring have been included in ISS plans, and hardware has been developed and ground-tested. Clinical procedures for controlling physiological changes during space flight (countermeasures) are being used to evaluate crew fitness and improve the astronauts' health.

Target Assessment: Green

Data Sources: Medical Check List; Well Book.

Verification/Validation: Crew and ground-support personnel are continuing the review and validation of procedures in addition to conducting flight readiness training. These pro-

tocols are to be located in the "Medical Check List" and "Well Book."

Performance Target: Evaluate and develop for flight testing a minimum of three major research protocols intended to protect bone, muscle, and physical work capacity and prepare a minimum of 10 biomedical research experiments, (utilizing the capabilities of the Space Shuttle and Station Human Research Facility) to study human responses to the gravitational environment. **FY 2000 Human Exploration and Development of Space #25 (0H25)**

HEDS investigators are evaluating and developing for flight testing three major research protocols to test methods for protecting bone, muscle, and physical work capacity. Thirteen experiments were prepared for the Space Shuttle and the ISS. This research is vital to the health and safety of future space travelers and produces insights important for medical practice here on Earth. For example, NASA researchers have produced promising results exploring the relationship between resistive exercise and bone density. These results may help older Americans prevent bone density loss associated with the aging process.

Actual Performance:

Protection of Physical Work Capacity

Aerobic Exercise protocol: Human subjects' muscle responses were analyzed during treadmill physiological testing. These experimental results, when combined with metabolic and biomechanical results allow for the development of a final protocol for in-flight testing of the treadmill on ISS.

Renal Stone Prevention: A flight protocol for validating potassium citrate administration to prevent kidney stones will be flown on STS-107. This investigation has been manifested as a science payload for the STS-107 mission and is scheduled for the ISS as well.

Orthostatic Intolerance (dizziness on standing): A protocol to validate Midodrine for the prevention of orthostatic intolerance has been developed and proposed for the Space Shuttle.

Protection of Bone and Muscle Capacity

Preliminary results of a bed rest evaluation to prevent bone loss using biphosphonates appear promising and are being evaluated in continuing research protocols.

Several studies of resistive exercise indicate that bone density increases with training programs employing low-repetition, high-load weightlifting. In testing a 12-week resistive exercise regimen, NASA found significant increases in bone mineral density in the spine.

Prepare a minimum of 10 biomedical experiments:
In support of meeting this target, there are 8 human life science experiments being prepared for the STS-107 mission and five human life science experiments being prepared for Increment 2 of the ISS. All of these experiments are beyond the critical design review phase of development.

Target Assessment: Green

Data Sources:

- The STS-107 Experiments and DSO's list
- Experiments Planned for ISS Increment 2
- Research Protocols

Verification/Validation:

- Review of experiment lists
- Review of publications
- Review before the Life and Microgravity Sciences and Applications Advisory Committee (LMSAAC)
- Review of research protocols

Performance Target: Complete the first phase (including outfitting of three test chambers) of the Advanced Life Support System Integration Test Bed facility, which will provide the capability to conduct a series of long-duration, human-in-the-loop, advanced technology tests over the next six years. Demonstrate key technology capabilities for human support, such as advanced techniques for water processing using microbes, waste processing using biological degradation and fluidized bed incineration, a no-expendable trace gas contaminant control system, solid waste processing, and flight test of a miniature mass spectrometer. **FY 2000 Human Exploration and Development of Space #31 (0H31)**

By successfully accomplishing this target, NASA made significant progress toward developing advanced new life-support technologies and improved approaches for maintaining health in the hostile environment of space.

Actual Performance: NASA completed utilities outfitting of the new BioPLEX closed life support test-chamber system. Progress continues in the development of key water recovery, solid waste processing, and atmospheric trace contaminant control technologies. Progress toward the development of more efficient and less resource intensive life support systems helps to reduce the cost of space flight while improving safety. Life support technologies may find applications in monitoring industrial processes and even air quality in homes, offices, and vehicles.

Supporting Details

BioPLEX power, external ventilation, and emergency monitoring systems and flooring are installed. Major test support systems designs are complete. A six-month evaluation of a hybrid water recovery system using microbes continues. Progress continues in the development of key water recovery, solid waste processing, and atmospheric trace contaminant control technologies.

The miniature mass spectrometer component passed testing at JPL with ammonia and hydrazines. It was delivered to JSC in November 1999, integrated into the full Trace Gas Analyzer unit, and is now undergoing integration and acceptance testing. JPL is supporting the test as required. The unit is being considered for an ISS flight. The Immobilized Microbe Microgravity Water Processing System is planned as a payload for a future Space Shuttle mission.

Target Assessment: Green

Data Sources:

- BioPLEX Test Facility (Project No. STB-P-263, JSC EC Master Document List)
- Advanced Life Support Weekly Reports
- The R2 (STS-117) Experiments and DSOs list
- Advanced Environmental Monitoring and Control Weekly Reports

Verification/Validation:

- Non-advocate Review of BioPLEX project
- BioPLEX Preliminary Design Review
- Review of proposed experiments for R2 mission
- Review of target by LMSAAC

Performance Target: Provide training to the appropriate NASA supervisors with specific emphasis on actions to prevent occupational injury and illness. Increase employee participation in the wellness program by at least 25 percent over the FY 1997 baseline. In coordination with the Office of Safety and Mission Assurance, achieve a 10 percent reduction in workers' compensation claims over the FY 1998 baseline. **FY 2000 Human Exploration and Development of Space #60 (0H60)**

By successfully achieving this target, NASA improved the health, safety, and efficiency of the NASA workforce.

Actual Performance: The NASA Administrator established a regular safety and health topics training effort, in which the Agency Senior Management team is given an overview of a specific safety or health issue which could lead to injury or illness. NASA Centers reported a 29 percent increase in the number of preventative health/wellness activities between FY 1997 and FY 2000 and increased safety led to a reduction of 13.5 percent in workers' compensation claims over the 1998 baseline.

Supporting Details

Supervisory Training:

Major new efforts for supervisory training have been initiated. Most significant is the NASA Administrator's regular safety and health topics training effort, in which the Agency senior management team is given an overview of a specific safety or health issue which could lead to injury or illness. Background information on the topic, best practices, specific actions being taken at the Agency and Center levels, and specific challenges and actions from the Administrator are discussed and posted on the NASA Web site and Infocom. That program has resulted in extensive improvements in Center safety and health program awareness and program development. Many additional enhancements have occurred in the training arena as follows:

- National Science and Technology Council (NSTC) course development and presentation

- Safety and Health Senior Managers conference
- Web-based training courses
- VPP readiness training
- Center-specific training programs

Increase Employee Participation in the Wellness Program by 25 percent over FY 1997 baseline:
Combined, NASA Centers reported a 28.75 percent increase in the number of preventive health/wellness activities between FY 1997 and FY 2000 despite the general population decrease. These wellness activities include preventive maintenance examinations, immunizations, wellness or fitness activities, and special programs (e.g., smoking cessation).

In addition, the Occupational Health Program Preventive Health Web site was established in 1998. The recorded 3,436 contacts the first year increased to 134,236 contacts in FY 2000. The rate of Preventive Health/Wellness activity went from a utilization rate of 1.44 per NASA Center employee in FY 1997 to 2.14 per employee in FY 2000. This represents an increase of at least 70 preventive health/wellness activities per 100 employees in FY 2000 compared to the FY 1997 baseline.

Workers' Compensation:
The baseline year of 1998 had claims costing NASA $7.4M. Fiscal Year 2000 claims costs totaled $6.4M for NASA, a reduction of 13.5 percent over the 1998 baseline.

Target Assessment: Green

Data Sources: Data are from NASA's Principal Center for Occupational Health at Kennedy Space Center.

Verification/Validation: Data are both tabulated and maintained by NASA's Principle Center for Occupational Health, located within the Division of Safety, Health, and Independent Assessment, Kennedy Space Center.

Goal: Expand commercial development of space.

Objective: Facilitate access to space for commercial researchers.

Our Space Product Development Program markets the benefits of space-based research to industry, facilitates industry's access to space, provides space research expertise and flight hardware, and advocates the development of policies to encourage commercial use of space. The program is executed through Commercial Space Centers that establish industry partnerships with the objective of developing new commercial space products or dual use technologies. The industry partners always invest substantial cash and/or in-kind resources in the projects. The NASA funding for the Space Product Development program is typically leveraged by an estimated $50M per year in resources contributed by other parties.

Some highlights of this for FY 2000 work include the following:

- The Wisconsin Center for Space Automation and Robotics received a Space Technology Hall of Fame 2000 Award from Space Foundation/NASA for innovative LED technology for medical applications. Originally used to light space-flown plant chambers, the LED technology is finding uses in photodynamic cancer therapy and wound healing.
- Bristol-Myers Squibb (BMS) continues its strategic partnership with the BioServe Space Technologies Commercial Space Center and is currently focusing with BioServe on microgravity fermentation research for improved production of antibiotics. Bristol-Myers Squibb will commit to BioServe a substantial level of cash and in-kind investment for the coming year and potentially double the commitment per year for the following four years. The partnership between BioServe and BMS is planned to continue into research on the ISS.
- Hewlett-Packard has signed a membership agreement with the Center for Commercial Applications of Combustion in Space. Hewlett-Packard scientists in Colorado will work with Center scientists to develop techniques for in situ imaging of bone in-growth into porous ceramic implants. They are partners in the Center's biomaterials consortium that includes BioServe Space Technologies, Guigné International Ltd., and Sulzer Orthopedics.
- The Wisconsin Center for Space Automation and Robotics flew a research experiment on STS-95 with industrial partner International Flavors and Fragrances. The results contributed to development of a new product marketed by Shiseido Company, Ltd.
- Two companies (Polaroid Corporation and Busek Co.,

Inc.) joined the Center for Advanced Microgravity Materials Processing as full members. The Center collaborated with Polaroid to build a system to explore the growth of silver halides, and testing is now underway.

Performance Target: Invest 25 percent of the space communications technology budget by FY 2000 in projects that could enable space commercial opportunities, including leveraging through a consortium of industry, academia, and Government. **FY 2000 Human Exploration and Development of Space #44 (0H44)**

This activity is an investment in future commercial space opportunities.

Actual Performance: This target of 25 percent was achieved through continuing investment in Advance Communication Technology Satellite (ACTS) experiments, advanced communications, Internet in space, and advanced space navigation with Global Positioning System (GPS). Expenditures amounted to approximately $10 million.

Target Assessment: Green

Data Sources: Relevant budget sources at the Center level.

Verification/Validation: Compare budget submits, Space Operations Management Office (SOMO) Technology Plan metrics.

Performance Target: Establish up to two new Commercial Space Centers. **FY 2000 Human Exploration and Development of Space #47 (0H47)**

Actual Performance: The Environmental Service Commercial Space Technology Center was established in FY 2000. The Center will give NASA improved access to commercial technologies in environmental services while facilitating the commercialization of NASA life-support technologies.

Supporting Details: A 90-day definition period Cooperative Agreement for the Environmental Service Commercial Space Technology Center was awarded to the University of Florida, beginning on September 1, 2000. The final Cooperative Agreement was signed in December 2000, for a five-year period with an intermediate review.

Target Assessment: Green

Data Sources: University of Florida Selection Letter.

Verification/Validation: Review of selection letter.

Performance Target: Foster the establishment of a telemedicine hub in Western Europe. NASA and CNES will develop an international telemedicine program to incorporate and connect existing medical informatics capabilities into a user-friendly commercial electronic telemedicine hub and apply lessons learned to human space flight. **FY 2000 Human Exploration and Development of Space #49 (0H49)**

NASA pioneered Telemedicine (providing medical care using telecommunications and information technologies) for space flight crews. Doctors and researchers around the world continue to develop and adapt telemedicine systems of increasing sophistication. In achieving this target, NASA improves its access to telemedicine technologies and approaches while contributing to improved health care delivery around the world.

Actual Performance: NASA Medical Informatics and Technology Applications Consortium has established a Memorandum of Understanding (MOU) in telemedicine with MEDES, a French research consortium. CNES, the French space agency, is not a signatory to the MOU, but was consulted in the MOU development process.

Target Assessment: Green, because the intent of the performance target was met, even though CNES was involved in a secondary instead of primary role.

Data Sources: Memorandum of Understanding between NASA and MEDES.

Verification/Validation: Review of above-mentioned Memorandum of Understanding.

Objective: Foster commercial participation on the International Space Station.

In preparation for commercial participation in Space Station Research, we supported small scale Space Shuttle research and established a Commercial Demonstration Program including a pricing policy, protections for intellectual property, and a process for reviewing and selecting entrepreneurial offers.

Performance Target: Utilize at least 30 percent of Space Shuttle and ISS FY 2000 capabilities for commercial investigations, per the U.S. Partner Utilization Plan. **FY 2000 Human Exploration and Development of Space #46 (0H46)**

This allocation demonstrates our commitment to commercial researchers and helps to develop a commercial research community for the International Space Station.

Actual Performance: NASA achieved 46 percent utilization for commercial investigators as measured by middeck locker volume.

Supporting Details: During FY 2000, there were four Shuttle missions flown.

There were a total of six middeck payloads flown during FY 2000, with Space Product Development (SPD) sponsoring two of them. Utilization by locker volume equates to three lockers out of 6.5, or 46 percent utilization during this period.

Mission	Date	Primary Purpose	Middeck Payloads	Lockers
STS-103	12/19/99	Hubble Space Telescope Servicing	None	0
STS-99	2/22/00	Shuttle Radar Topography Mission	None	0
STS-101	5/19/00	ISS Assembly 2a.2a	SPD—Commercial Protein Crystal Growth	2
			SPD—Astroculture	1
			UG—Protein Crystal Growth Bag	1
			UL—BioTube	0.5
STS-106	9/20/00	ISS Assembly 2a.2b	UL—Commercial Generic Bioprocessing Apparatus	1
			UG —Enhanced Gaseous Nitrogen Dewar	1

Target Assessment: Green

Data Sources: Shuttle flight manifests as summarized above.

Verification/Validation: See table below (based on review of Shuttle flight manifests).

Goal: Share the experience and discovery of human space flight.

Objective: Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.

During FY 2000 NASA produced an electronic light tower exhibit, which traveled to five conventions across the country, presenting the complete story of the development and use of the ISS to over 100,000 citizens. In addition, NASA exhibited at educational conventions across the country, supplying products to educators. On the lecture circuit, NASA sponsored a special session to present life sciences concepts to about eight museum curators throughout the country for consideration in museum exhibit planning. NASA conducted six-week programs for academically gifted undergraduate students at NASA Field Centers and gave students throughout the country an additional opportunity to participate in hands-on investigations with space-flown seeds.

Finally, in preparation for scientific use of the ISS, students from middle and high schools in Alabama, California, Florida, and Tennessee helped with the first long-duration experiment to be delivered to the ISS, preparing 150 biological samples. Students and teachers from 20 other States attended classes as part of the pilot education program, sponsored by Marshall Space Flight Center. To further interest students in biotechnology, NASA is sponsoring teacher workshops and providing curricular materials, including crystal growth experiments.

Performance Target: The NASA-Sponsored National Space Biomedical Research Institute (NSBRI) will conduct an open symposium relaying the results of space-oriented research activities focusing on up to 10 ground-related applications with the participation of interested

investigators; publish results in a conference proceedings report. **FY 2000 Human Exploration and Development of Space #56 (0H56)**

These outreach efforts help to ensure that NASA gains full access to biomedical research expertise around the country.

Actual Performance: The NSBRI conducted an institute-based investigators meeting January 10–13, 2000. Over 280 participating researchers attended the meeting. Physiological discipline teams reviewed current state-of-the-art research with their research programs. The meeting provided an environment for researchers to take the time to more fully understand the total scope of the NSBRI research efforts and to promote further collaboration across discipline teams. Proceedings of the meeting have been published. The NSBRI supported the 11th International Conference on Biochemistry of Exercise, held at the University of Arkansas for Medical Sciences, June 4–7, 2000. It focused on Molecular Aspects of Physical Activity and Aging. NSBRI sponsored the symposium entitled, "Computers in Cardiology," held on September 24, 2000. NSBRI cardiovascular alterations team

HEDS FY 2000 TREND DATA

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Enable human exploration through collaborative robotic missions.				0H35	Complete the integration and testing of the Mars in situ Propellant Production Precursor (MIP) flight unit for the 2001 Mars Surveyor mission.	Red	New target.
Define innovative, safe, and affordable human exploration mission architectures.				0H36	Complete the development and initiate the implementation of a comprehensive technology investment strategy to support future human exploration that includes capability development for increasing self-sustainability, decreasing transit times, developing commercial opportunities, reducing cost and risk, and increasing knowledge and operational safety.	Green	New target.
Invest in enabling high-leverage exploration technologies.				0H38	In coordination with other Enterprises, develop and implement tests and demonstrations of capabilities for future human exploration in the areas of advanced space power, advanced space transportation, information and automation systems, and sensors and instruments.	Yellow	New target.
Provide safe and affordable access to space.			Green	0H15	Have in place an aggressive Shuttle program that ensures the availability of a safe and reliable Shuttle system through the ISS era.	Red	New target.
Provide safe and affordable access to space.	9H15	Achieve 7 or fewer flight anomalies per mission.	Green	0H12	Achieve 7 or fewer flight anomalies per mission.	Green	The target was modified to include the entire set of in-flight anomalies (IFAs) for each mission to capture all potential issues associated with a particular flight, not just those that affected the Orbiter during the mission.

HEDS FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
(Continued from previous page)	9H15						With this change, the target was adjusted to "Achieve 8 or fewer IFAs per mission."
Provide safe and affordable access to space.	9H16	Achieve 85% on-time, successful launches, excluding weather risk.	Red	0H13	Achieve 85% on-time, successful launches, excluding weather risk.	No Longer Applicable.	The Administrator and the Associate Administrator for Space Flight, along with the Space Shuttle Program Manager, believed that the targeted performance might be interpreted as compromising safety.
Provide safe and affordable access to space.	9H17	Achieve a 12-month flight manifest preparation time.	Green	0H14	Achieve a 12-month flight manifest preparation time.	Green	The 12-month template was achieved for one mission implemented in FY 2000. Having a 12-month flight manifest preparation time (template) gives the Space Shuttle program a great deal of flexibility in manifesting for short-notice requirements, as well as giving program customers a good sense of what is required (with lead times) to fly on the Space Shuttle.
Provide safe and affordable access to space.	9H18	Achieve a 60% increase in predicted reliability of Space Shuttle over 1995.	Green				Target eliminated.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.	9H19	Deploy and activate the Russian-built Functional Cargo Block as the early propulsion and control module.	Green				Target eliminated.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.	9H41	Deploy and activate the first U.S.-built element, Unity (Node 1), to provide docking locations and attach ports.	Green				Target eliminated.

HEDS FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.	9H42	Initiate full-scale Multi-Element Integration Testing (MEIT) for elements in the first four launch packages.	Green				Target eliminated.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.	9H44	Conduct physical integration of the Z1 Truss launch package and initiate MEIT.	Green				Target eliminated.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.	9H43	Deliver the U.S. laboratory module to the launch site in preparation for MEIT.	Green	0H16	Deploy and activate the U.S. Laboratory Module to provide a permanent onorbit laboratory capability.	Yellow	The lab was not launched during FY 2000 as planned. Progress was significant and the launch occurred in January 2001.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.				0H17	Deploy and activate the Canadian-built SSRMS to provide an ISS-based remote manipulating capability for maintenance and assembly.	Yellow	New target.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.				0H18	Deploy and activate the Airlock to provide an ISS-based EVA capability.	Yellow	New target.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.				0H19	Deliver to orbit the first of three Italian-built MPLM to provide a reusable capability for delivering payload and systems racks to orbit.	Yellow	New target.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.				0H61	Conduct operations with a three-person human presence on the ISS.	Yellow	New target.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.				0H20	Complete preparations for the initial ISS research capability through the integration of the first rack of the Human Research Facility (HRF-1), five ERs, with small payload research, and the MSG.	Yellow	New target.

HEDS FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.				0H22	Complete the production of the X-38 first space flight test article in preparation for a Shuttle test flight in 2001.	Yellow	New target.
Meet strategic space operations needs while reducing costs and increasing standardization and interoperability.	9H30	Complete the development of a commercialization plan for the ISS and Space Shuttle in partnership with the research and commercial communities, and define and recommend policy and legislative changes.	Yellow	0H39	Promote privatization of Space Shuttle operations and reduce civil service resource requirements for operations by 20% (from the FY 1996 FTE levels) in FY 2000.	Red	This target was not tracked, following NASA's decision to hire additional staff to assure that safety would not be compromised for Space Shuttle missions.
Meet strategic space operations needs while reducing costs and increasing standardization and interoperability.	9H30	Complete the development of a commercialization plan for the ISS and Space Shuttle in partnership with the research and commercial communities, and define and recommend policy and legislative changes.	Yellow	0H40	Promote privatization and commercialization of Space Shuttle payload operations through the transition of payload management functions (payload integration managers, payload officers, etc.) by FY 2000.	Green	Progress towards transition of payload management functions.
Meet strategic space operations needs while reducing costs and increasing standardization and interoperability.				0H41	Within policy limitations and appropriate waivers, pursue the commercial marketing of Space Shuttle payloads by working to allow the Space Flight Operations Contractor to target two reimbursable flights, one in FY 2001 and one in FY 2002.	No Longer Applicable.	There are no reimbursable flights planned in FY 2001 or FY 2002.
Meet strategic space . operations needs while reducing costs and increasing standardization and interoperability.	9H33	Reduce space communications operations costs by 30–35% compared to the FY 1996 budget, through a consolidated space communications contract to meet established budget targets.	Green	0H43	Reduce space communications budget submit for FY 2000 by 30–35% from the FY 1996 Congressional budget submit.	Green	Progress made as budget authority was reduced by 36%.

HEDS FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Meet strategic space operations needs while reducing costs and increasing standardization and interoperability.	9H34	Develop options and recommendations to commercialize space communications.	Red	0H42	Increase the expenditures for commercial services to 10% of the total space communications budget by FY 2000.	Green	Progress made as commercial expenditures were over 10% of the total budget.
Facilitate access to space for commercial researchers.				0H44	Invest 25% of the space communications technology budget by FY 2000 in projects that could enable space commercial opportunities, including leveraging through a consortium of industry, academia, and Government.	Green	New target.
Enable human exploration through collaborative robotic missions.	9H26	Initiate a collaborative program to design and develop instruments.	Green	0H33	Complete Radiation Research Instrument for the Mars 2001 mission to study transit, orbital, and surface radiation effects and conduct three workshops to define and prioritize research tasks in subjects such as radiation shielding materials, in situ resource utilization, and fluids management and heat transfer technology. Complete the science definition of granular flows, flight, and dust management experiments to begin gathering research data to alleviate critical problems of dust buildup, habitat foundation engineering, and rover performance during planetary exploration.	Green	Plans for robotic Mars missions have been restructured since these targets were developed. Instruments and work-shops under 0H33 were completed, but the Mars 2001 mission was re-planned.
In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems.	9H1	Support an expanded research program of approximately 800 investigations, an increase of ~9% over FY 1998.	Green	0H1	Support an expanded research program of approximately 935 investigations, an increase of ~17% over FY 1999. Publish 100% of science research progress in the annual OLMSA Life Sciences and Microgravity Research Program Task Bibliographies and make this available on the Internet.	Green	OLMSA continues to significantly increase the number of investigations it funds, and makes resulting findings widely accessible.
In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems.	9H2	Publish 90% of FY 1998 science research progress in the annual OLMSA Life Sciences and Microgravity Research Program Task Bibliographies and make it available on the Internet.	Green				Targets 9H2 and 9H1 combined to form FY 2000 target 0H1.

HEDS FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems.	9H3	Establish a National Center for Evolutionary Biology with participation of at least 5 research institutions and engaging at least 20 investigators.	Green				Target completed.
In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems.	9H13	Use data obtained by fluid physics experiments on suspensions of colloidal particles on MSL-1 to answer fundamental questions in condensed matter physics regarding the transition between liquid and solid phases and publish data on the transition from liquids to solids and the results in peer-reviewed open literature.	Green	0H11	Using suborbital rockets, complete one combustion experiment on the flame spread of liquid fuels to better control Earth/space-based fire hazards, and conduct one investigation to test theories of fundamental physics properties and physical laws of fluids to provide key data for Earth and space-based processing materials; report the results.	Red	Targets reflect specific experiments in fluid physics and combustion science.
In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems.				0H9	Complete data reduction from the STS-95 Research Module mission. Begin to explore new cooperative efforts with NIH in the area of aging and transfer space-derived research for industry development of a new drug to treat Chagas disease.	Green	New target.
In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems.	9H11	Improve predictive capabilities of soot processes by at least 50% through analysis of MSL-1 data; publish results in peer-reviewed open literature.	Green				Target completed.
In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems.	9H12	Use MSL-1 results to eliminate one of the three primary fluid flow regimes from consideration by casting engineers, and publish this result in peer-reviewed literature. Casting engineers may use this information to improve metal casting processes in industry.	Green				Target completed.

HEDS FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
	9H9	Analyze Mir data to achieve a 3-year jump-start for cell culture and protein crystal growth research and document analyses and lessons learned.	Green				Target completed.
Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.	9H23	Initiate preparations for the launch of the first EXPRESS Rack with 5 payloads on assembly flight 7A.1.	Green				Target completed.
Ensure and enhance the health, safety, and performance of humans in space.	9H7	Document Mir data lessons learned to facilitate ISS biomedical and countermeasure research.	Green	0H26	Develop medical protocols and test the capability of the CHeCS as integrated in the ISS U.S. laboratory.	Green	NASA is applying the results of previous space flight experiments to new systems and techniques that will ensure astronaut safety.
Ensure and enhance the health, safety, and performance of humans in space.	9H25	Complete the development of countermeasure research protocols, and begin testing a minimum of three countermeasures intended to protect bone, muscle, and physical work capacity.	Green	0H25	Evaluate and develop for flight testing a minimum of three major research protocols intended to protect bone, muscle, and physical work capacity and prepare a minimum of 10 biomedical research experiments, (utilizing the capabilities of the STS and ISS HRF) to study human responses to the gravitational environment.	Green	Progress continues to be made in the expansion of our understanding of how the space environment affects humans, as well as in the development of techniques for minimizing adverse effects.
Ensure and enhance the health, safety, and performance of humans in space.	9H8	Document Mir data lessons learned to facilitate ISS research in fundamental biology and regenerative life support.	Green				Target completed.
Ensure and enhance the health, safety, and performance of humans in space.	9H10	Document Mir radiation research data to facilitate ISS EVA planning.	Green				Target completed.
Ensure and enhance the health, safety, and performance of humans in space.	9H5	Publish a report of comparison of 3 different biological models to understand the influence of gravity on the nervous system.	Green				Target eliminated.
Ensure and enhance the health, safety, and performance of humans in space.	9H6	Publish a report defining the time course adaptations in the balance system to altered gravitational environments.	Green				Target eliminated.

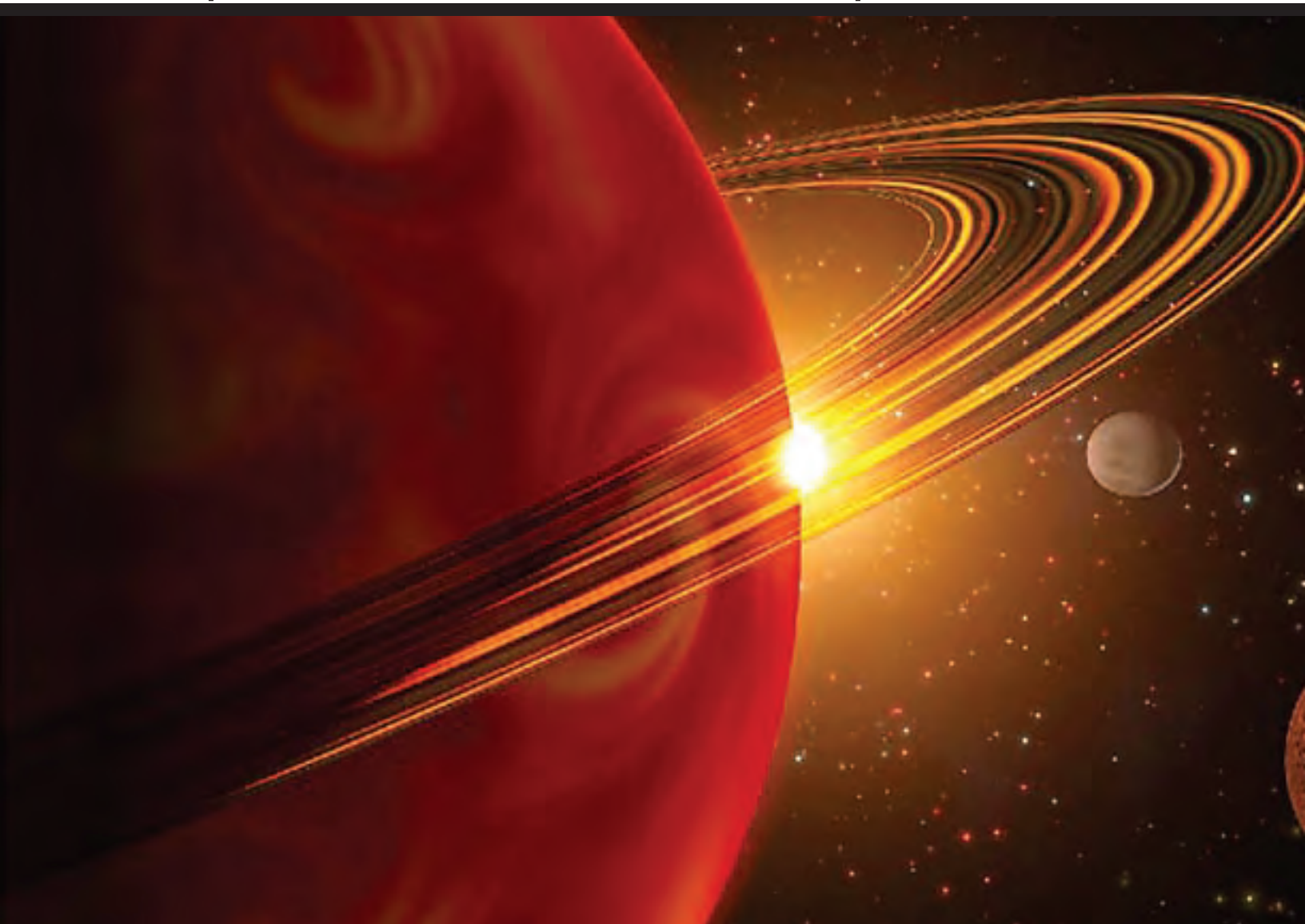
HEDS FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Ensure and enhance the health, safety, and performance of humans in space.	9H29	Perform component and subsystem ground tests without humans in the loop to demonstrate advanced technologies, including biological water processor, and flight test a new electronic "nose" sensor on a chip.	Green	0H31	Complete the first phase (including outfitting three test chambers) of the Advanced Life Support System Integration Test Bed facility that will provide the capability to conduct a series of long duration, human-in-the-loop, advanced technology tests over the next six years. Demonstrate key technology capabilities for human support, such as advanced techniques for water processing using microbes, waste processing using biological degradation and fluidized bed incineration, a no-expendable trace gas contaminant control system, solid waste processing, and flight test of a miniature mass spectrometer.	Green	NASA is developing the ground-based infrastructure to conduct extensive tests of various advanced life support technologies and systems that will be used to extend the human presence in space.
Ensure and enhance the health, safety, and performance of humans in space.				0H60	Provide training to the appropriate NASA supervisors with specific emphasis on actions to prevent injury and illness on the job. Increase employee participation in the wellness program by at least 25% over FY 1997 baseline. In coordination with the Office of Safety and Mission Assurance, achieve a 10% reduction in workers' compensation claims over the FY 1998 baseline.	Green	New target.
Ensure and enhance the health, safety, and performance of humans in space.	9H39	Conduct at least two demonstrations of the applicability of the "Telemedicine Instrumentation Pack" for health care delivery to remote areas.	Green				Target eliminated.
Facilitate access to space for commercial researchers.	9H36	Establish a new food technology Commercial Space Center.	Green	0H47	Establish up to 2 new Commercial Space Centers.	Green	NASA continues to develop Commercial Space Centers to enable non-NASA researchers to explore the entrepreneurial possibilities of space for a variety of industries.

HEDS FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Facilitate access to space for commercial researchers.	9H35	Increase non-NASA investment (cash and in-kind) in space research from $35M in FY 1996 to at least $50M in FY 1999, a 40% increase.	Green	0H49	Foster the establishment of a telemedicine hub in Western Europe. NASA and CNES will develop an international telemedicine program to incorporate and connect existing medical informatics capabilities into a user-friendly commercial electronic telemedicine hub and apply lessons learned to human space flight.	Green	NASA is working to encourage increased investment in space from non-NASA sources. An MOU between NASA and a French research consortium has laid the groundwork for the development of an international telemedicine program.
Foster commercial participation on the International Space Station.	9H30	Complete the development of a commercialization plan for the ISS and Space Shuttle in partnership with the research and commercial investment communities and define and recommend policy and legislative changes.	Yellow	0H46	Utilize at least 30% of Space Shuttle and ISS FY 2000 capabilities for commercial investigations, per the U.S. Partner Utilization Plan.	Green	NASA is working to ensure commercial access to its human space flight assets.
Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.	9H37	Initiate a curriculum development program, in partnership with the International Technology Education Association (ITEA), for gravity-related educational modules for national distribution, which meet the current National Science Teachers Association (NSTA) National Standards for Science for Grades K-12, and the ITEA National Standards for Technology Education to be published June 1999.	Green	0H56	The NASA-sponsored National Space Biomedical Research Institute will conduct an open symposium relaying the results of space-oriented research activities focusing on up to 10 ground-related applications with the participation of interested investigators; publish results in a conference proceedings report.	Green	NASA continues to make the results of space research available to a wide audience.
Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.	9H40	Demonstrate the application of laser light scattering technology for early detection of eye tissue damage from diabetes; publish results in peer-reviewed open literature.	Green				Target completed.
Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.	9H38	Expand the microgravity research program World Wide Web-based digital image archive established in 1998 by 50%.	Green				Target completed.

Space Science Enterprise



FY 2000 Space Science Enterprise

Goals

The four goals of the Space Science Enterprise are as follows:

- Develop new critcal technologies to enable innovative and less costly mission and research concepts;
- Chart the evolotion of the universe from origins to destiny, and understand its galaxies, stars, planets, and life;
- Contribute measurably to achieving the science, mathematics, and technology education goals of our Nation, and share widely the excitement and inspiration of our missions and discoveries; and
- Support all goals.

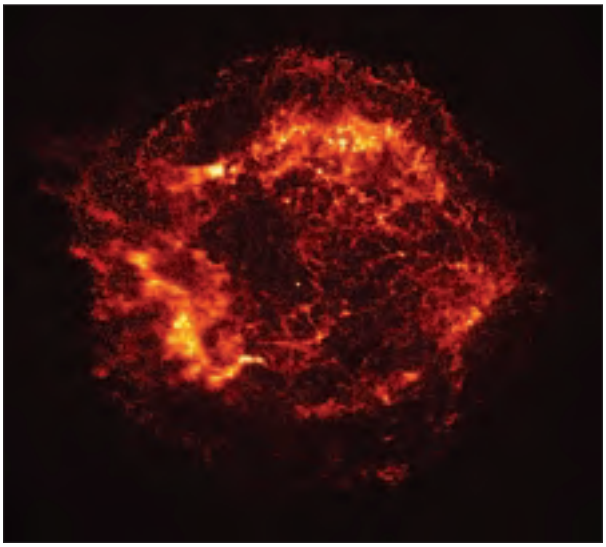
Fiscal Year 2000 Performance Plan

To gauge progress across this spectrum of activities, the Enterprise established 65 specific project and program performance targets. In addition, broad scientific progress has been assessed against 19 science objectives detailed in the Space Science Enterprise Strategic Plan.

For the Space Science Enterprise, FY 2000 held significant scientific accomplishments, as well as disappointments in some development and technology programs. Perhaps most notable among the disappointments was the loss of the Mars Polar Lander spacecraft upon arrival at Mars, which led to a newly restructured Mars Exploration Program (MEP). The new program places an increased emphasis on risk management, and adopts a "seek, in situ, sample" approach that employs surface and orbital reconnaissance to gain an understanding of the planet that will lead to multiple sample returns.

Among the Enterprise's most significant achievements this year was the spectacular Mars Global Surveyor imaging suggesting that liquid water has seeped onto the surface of Mars in the geologically recent past. In order to support the new MEP strategy, high-resolution orbital imaging will follow these results, and increasingly advanced landers will be interspersed with these orbital missions.

BOOMERANG (Balloon Observations of Millimetric Extragalactic Radiation and Geophysics) balloon-borne observations sharpened our view of the beginnings of structure very early in the history of the universe, building on Cosmic Background Explorer (COBE) observations from the late 1980's. The Chandra X-ray Observatory (CXO)



Chandra image of Cassiopeia A.

continued to operate flawlessly, exceededing efficiency and data recovery expectations. The CXO has resolved most of the x-ray background, providing new insight on conditions many billions of years ago. Fiscal Year 2000 marked the 10th anniversary of the Hubble Space Telescope (HST), which continues to produce amazing images of the universe, holding the fascination of students, teachers, and the public. This has made the "New Views of the Universe" traveling exhibit a highly popular destination for museum and science center visitors nationwide.

The Transition Region and Coronal Explorer (TRACE) spacecraft has provided dramatic images of the Sun's outer atmosphere, called the corona. Data from the TRACE mission are extremely valuable because eruptive events occurring in this region can disrupt high technology systems on Earth.

Following on Galileo's intensive study of Europa, which yielded evidence supporting the possibility of a liquid ocean beneath its crust, this mission has also obtained dramatic images of other satellites of Jupiter. Recent images include volcanic craters on the satellite Io. NASA significantly exceeded expectations for data recovery on the Io encounters.

Finally, the Enterprise continues to make important progress in the education and public outreach (E/PO) area. All new missions include a funded component dedicated to education and public outreach, the online Resource Directory is in place, and targets for expanding the distribution of activities among the States and regions were significantly exceeded. A particularly valuable effort initiated in FY 2000 involves the development of approaches to assess the educational quality and effectiveness of the Space Science E/PO program.

Performance Measures

The Space Science Enterprise demonstrated successful performance on 34 of the 65 performance targets and 18 of the 19 science objectives for FY 2000. Several targets were not achieved due to management response to changing conditions (HST, Mars '01, and Mars Future Development). Such management decisions can compromise the timely achievement of previously designated performance targets, but they are critical to improving Space Science programs and safeguarding valuable program assets. A number of other delays in target achievement were due to matters beyond the Enterprise's control (TIMED [Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics] Development, TIMED Operations, Astro-E Operations, Solar-B, STEREO [Solar-Terrestrial Relations Observatory], and Voyager). It is noteworthy that, in spite of a number of project milestone setbacks, Enterprise performance was fully effective in 18 of 19 science objective areas, as determined by external independent review.

Performance against each of the 65 targets is discussed below.

Goal: Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life.

Objective: Solve mysteries of the universe.

Performance Target: The Chandra X-ray Observatory (formerly AXAF) instrument will meet nominal performance expectations, and science data will be taken with 70 percent efficiency, with at least 90 percent of science data recovered on the ground. **FY 2000 Space Science #1 (0S1)**

Actual Performance: Accomplished. Chandra has observed high-energy events such as pulsars, black holes, and supernova remnants. All of the CXO instruments continued to operate nominally with excellent science return. Overall operational efficiency has exceeded 88 percent, and more than 99 percent of the science data has been recovered on the ground.

Target Assessment: Green

Data Source: Certified by project manager, Marshall Space Flight Center, based on periodic mission status reports.

Verification/Validation: Certified by Deputy program scientist and program executive, based on periodic mission status reports from the CXO Center (MSFC).

Performance Target: Complete final integration and test of the Gravity Probe-B science payload with the spacecraft in August 2000. **FY 2000 Space Science #3 (0S3)**

Actual Performance: Once launched, this mission will test Einstein's general theory of relativity. However, targeted per-

formance was not accomplished due to a thermal problem in the probe and a failure of Gyro #4 within the cryogenic probe. Expected to be accomplished in late FY 2001.

Target Assessment: Yellow

Data Source: Certified by project manager, MSFC, based on project monthly status reports.

Verification/Validation: Certified by project manager, MSFC, and program executive, based on project monthly status reports.

Performance Target: Successfully install and activate three key Hubble upgrades during the third servicing mission: flight computer, advanced camera, and solar arrays. Maintain an average on-target pointing efficiency of 35 percent during FY 2000 operations before they are interrupted for the third servicing mission, presently scheduled for May 2000. **FY 2000 Space Science #4 (0S4)**

Actual Performance: Partially accomplished. Periodic visits by astronauts for maintenance and upgrade of the orbiting observatory with state-of-the-art instruments and cameras have kept the Hubble at the forefront of astronomy for 10 years. Part "B" of the third servicing mission, during which astronauts will install a new camera, flight computer, and solar panels, among other upgrades, is scheduled to launch late this year. Due to gyro failures, the third Servicing Mission (SM) was split into two missions, SM3A and SM3B. An additional gyro failure would have caused the observatory to go into "safe mode," during which no observations can be made. SM3A, during which the flight computer was installed, was completed in December 1999. All primary objectives for SM3A were satisfied and the mission fully met the criteria. The on-target pointing efficiency was met as well.

Target Assessment: Yellow

Data Source: Certified by program manager, GSFC, based on program monthly status reports.

Verification/Validation: Certified by program manager, GSFC, and program executive, based on program monthly status reports.

Hubble Space Telescope (HST) view of the "Eskimo" Nebula.

Performance Target: Complete the SOFIA 747 Section 46 mockup test activity during June 2000, with no functional test discrepancies that would invalidate CDR-level designs and cause significant design rework, with attendant cost and schedule impact. **FY 2000 Space Science #43 (0S43)**

Actual Performance: Accomplished. When operational, the Stratospheric Observatory for Infrared Astronomy (SOFIA), an observatory aboard an aircraft, will observe a wide range of objects in the universe to help understand the formation of planets, stars, and galaxies, as well as the evolution of complex organic molecules in space. The Section 46 mockup test activity was successfully completed by April 1, 2000.

Target Assessment: Green

Data Source: Certified by project manager at ARC, and reported at regular monthly review.

Verification/Validation: Certified by project manager at ARC and program executive; reported at regular monthly review.

Performance Target: Deliver the Space Infrared Telescope Facility (SIRTF) Infrared Array Camera (IRAC), Multiband Imaging Photometer (MIPS), and Infrared Spectrograph (IRS) instruments during April 2000. The instruments shall perform at their specified levels at delivery. **FY 2000 Space Science #5 (0S5)**

HST view of a spectacular silhouette, a face-on spiral galaxy positioned precisely in front of another large spiral.

Actual Performance: Partially accomplished. NASA's last Great Observatory, the SIRTF, will observe stars, planets, and galaxies in infrared light, allowing the telescope to see through interstellar dust clouds. In addition, this special capability will allow SIRTF to see objects extremely far away and invisible to current telescopes, including the Hubble Space Telescope, because these far distant objects "shine" only in infrared light. The performance target was met for two of the three science instruments. The IRAC instrument did not meet the target; achievement occurred in FY 2001. Delay in IRAC was due to hardware problems and completion of software development activities.

Target Assessment: Yellow

Data Source: Certified by project manager, and reported at quarterly review.

Verification/Validation: Certified by project manager and program executive; reported at August 2000 GPMC quarterly review.

Performance Target: Prepare the International Gamma Ray Astrophysics Laboratory (INTEGRAL) Science Data Center (ISDC) for data archiving and prepare instrument analysis software for the spectrometer on INTEGRAL (SPI) instrument within 10 percent of estimated cost. **FY 2000 Space Science #6 (0S6)**

Actual Performance: Accomplished. This mission will provide information on the supernova history of the Milky Way.

The target was achieved through the use of two veteran software teams. The ISDC software has been completed (at 7.0 percent over estimated cost), as have both portions of the SPI software (at 8.8 percent under estimated cost). (When combined, the cost was 3.9 percent under the estimate.) As a result, the science analysis programs will be completed prior to launch, allowing for the immediate analysis of the data collected by INTEGRAL within the allotted resource budget.

Target Assessment: Green

Data Source: Certified by project manager, GSFC.

Verification/Validation: Certified by project manager, GSFC, and program executive, based on program status reports.

Performance Target: Assemble and successfully test the breadboard cooler for ESA's Planck mission in April 2000. **FY 2000 Space Science #7 (0S7)**

Actual Performance: Not accomplished. Planck will improve previous measurements of the cosmic microwave background by a factor of five. Amount and phasing of program funding was not consistent with schedule. Target expected to be completed in FY 2001.

Target Assessment: Yellow

Data Source: Certified by project manager, JPL.

Verification/Validation: Certified by project manager, JPL, and program executive, based on program status reports.

Performance Target: Deliver the Galaxy Evolution Explorer (GALEX) science instrument from JPL to the Space Astrophysics Laboratory at Caltech during April 2000 for science calibration. The instrument will be fully integrated, functionally tested, and environmentally qualified at the time of the scheduled delivery. **FY 2000 Space Science #8 (0S8)**

Actual Performance: Not accomplished. This mission will increase the understanding of how galaxies evolved. Problems were encountered in detector development and telescope fabrication, coupled with delays in electronics development due to loss of key personnel. Shipment planned for late FY 2001.

Target Assessment: Yellow

Data Source: Certified by Explorer program manager, GSFC, and reported in Monthly Status Review (MSR) to the Goddard Governing Program Management Council (GPMC).

Verification/Validation: Certified by Explorer program manager, GSFC, and program executive; reported in MSR to the Goddard GPMC.

Performance Target: Begin system-level environmental testing of the Microwave Anisotropy Mission (MAP) spacecraft during July 2000. **FY 2000 Space Science #9 (0S9)**

Actual Performance: Accomplished within projected fiscal quarter. MAP will determine whether the first large structures in the universe after the Big Bang were galaxies or clusters of galaxies. Testing began in September 2000, a slight delay due to technical problems with electronic parts (interpoint converters). (Industry-wide alert led to change-out.) All work was completed within two months of the original schedule and within the fiscal year.

Target Assessment: Green

Data Source: Certified by Explorer program manager, GSFC, and reported in MSR to the Goddard GPMC.

Verification/Validation: Certified by Explorer program manager, GSFC, and program executive; reported in MSR to the Goddard GPMC.

Performance Target: The baseline mission of the Compton Gamma Ray Observatory (CGRO) ended in 1996; the target for FY 2000 is to continue to operate those instruments not dependent on expended consumables (Oriented Scintillation Spectrometer Experiment [OSSE], Burst and Transient Source Experiment [BATSE], and Imaging Compton Telescope [COMPTEL]) at an average efficiency of at least 60 percent. **FY 2000 Space Science #11 (0S11)**

Actual Performance: Accomplished for first eight months of fiscal year; spacecraft then de-orbited in accordance with NASA's safety priorities. CGRO made many fundamental discoveries and observed approximately 400 gamma ray sources. Before CGRO, only about 40 were known. Spacecraft deorbited June 4, 2000 for safety reasons; performance target met until that time.

Target Assessment: Green

Data Source: Certified by deputy program scientist, based on confirmed spacecraft controlled re-entry.

Verification/Validation: Certified by deputy program scientist, based on confirmed spacecraft controlled re-entry.

Performance Target: The three-year Far Ultraviolet Spectropic Mission (FUSE) mission will complete at least one-third of the observations needed for its minimum science program, with six of the eight instrument performance parameters being met. **FY 2000 Space Science #12 (0S12)**

Actual Performance: Accomplished. FUSE has been among the most successful space observatories ever launched, despite its modest cost and size. FUSE has observed everything from planets in our solar system to quasars halfway across the universe, resulting in numerous scientific papers. One of the goals of FUSE is to observe leftover material from the Big Bang in order to glean important insights into conditions in the very early universe. During the 10 months of the first mission year that occurred in FY 2000, FUSE completed approximately 50 percent of the observations needed for the minimum science program, with seven of the eight instrument performance parameters being met.

Target Assessment: Green

Data Source: Certified by project scientist, GSFC. (From regular FUSE calibration reports and meetings, science team meetings, and periodic reviews of the observatory's performance.)

Verification/Validation: Certified by program scientist. (From regular FUSE calibration reports and meetings, sci-

ence team meetings, and periodic reviews of the observatory's performance.)

Performance Target: The prime mission of Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX) ended in 1995; the FY 2000 target is to obtain at least 60 percent data coverage from at least three of SAMPEX's four instruments. **FY 2000 Space Science #15 (0S15)**

Actual Performance: Accomplished. SAMPEX investigates the origins of solar energetic particles. SAMPEX has obtained 98.5 percent data coverage from the four instruments.

Target Assessment: Green

Data Source: Weekly and monthly progress reports; certified by project manager, GSFC.

Verification/Validation: Certified by program scientist, based on October 26, 2000, project status report.

Performance Target: The baseline Rossi X-Ray Timing Explorer (RXTE) mission ended in 1997; the target for FY 2000 is to operate at least three of the five instruments at an efficiency of 45 percent, with 95 percent data recovery; All-Sky Monitor (ASM) data will be posted on the Web within seven days, and Proportional Counter Array and High-Energy X-ray Timing Experiment (HEXTE) data will be released within 60 days. **FY 2000 Space Science #2 (0S2)**

Actual Performance: Accomplished. RXTE observes the fast-moving, high-energy worlds of black holes, neutron stars, and x-ray pulsars, and has provided evidence for spinning black holes in active galaxies.

The RXTE instruments continued to meet or exceed their operational goals, with at least three of the five PCU (Proportional Counter Unit) detectors of the PCA (Proportional Counter Array) instrument operating with an efficiency of better than 50 percent and with data recovery exceeding 95 percent. Data dissemination from the RXTE instruments also met the established target level, with ASM and HEXTE data made publicly available in less than one week and two months, respectively, from time of receipt by the PI teams. (Note: RXTE has only three instruments; the target refers to three of five PCU detectors.)

Target Assessment: Green

Data Source: Certified by program scientist, GSFC. Based upon mission status reports at Science Working Group (SWG) meetings.

Verification/Validation: Certified by program scientist, GSFC, and Headquarters project scientist. Based upon mission status reports at SWG meetings.

Performance Target: If launched, activate the X-ray Spectrometer (XRS) and X-ray Imaging Spectrometer (XIS) instruments on the Japanese Astro-E spacecraft after launch and collect at least 90 percent of the XRS and XIS data. **FY 2000 Space Science #14 (0S14)**

Actual Performance: Not applicable. The launch vehicle for the Japanese Astro-E spacecraft failed to achieve orbit. This mission was to measure the energies of individual x-rays with increased precision. NASA is investigating the possibility of collaborating with Japan on an Astro-E2 mission.

Target Assessment: Red

Data Source: Institute for Space and Astronautical Science (ISAS) Report. (ISAS is the Japanese sponsoring agency.)

Verification/Validation: Certified by program executive, based on ISAS Report and project status report.

Performance Target: Complete the Next Generation Space Telescope (NGST) Developmental Cryogenic Active Telescope Test Bed (DCATT) Phase 1, measure ambient operation with off-the-shelf components, and make final preparations for Phase 2, the measurement of cold telescope operation with selected "flight-like" component upgrades. **FY 2000 Space Science #53 (0S53)**

Actual Performance: Not accomplished. The Next Generation Space Telescope will look back to an extremely important period in the early history of the universe when the first stars and galaxies began to form. NGST will help us understand the shape and chemical composition of the uni-

verse, the evolution of galaxies, and the nature of unseen "dark matter." These technologies are critical to the operation and optimization of segmented optics, which it is envisioned will be used by NGST and other telescopes. DCATT Phase 0 was successful. However, Phase 1 was not successful due primarily to problems with the segmented one-meter telescope addition. As a result of these problems, the wavefront sensing and control effort was changed (both management and test bed approach) in October 1999 to correct the problems in the original DCATT effort. The new program involves a mix of in-house work and the prime industry teams to develop a series of Wavefront Control Test Beds (WCT) that develop, test, and validate algorithms and processes for wavefront control. The new program is in place and on schedule. There has been no impact to the NGST launch readiness as a result of problems encountered in phase 1 and the subsequent redirection of the effort.

Target Assessment: Red

Data Source: Certified by project manager, GSFC.

Verification/Validation: Certified by project manager, GSFC, and program executive, based on project status reports.

Performance Target: Demonstrate performance of the Superconductor-Insulator-Superconductor (SIS) mixer to at least 8hv/k at 1,120 GHz and 10hv/k at 1,200 GHz. The U.S. contribution to the ESA Far Infrared and Submillimeter Telescope (FIRST) is the heterodyne instrument, which contains the SIS receiver. **FY 2000 Space Science #62 (0S62)**

Actual Performance: Not accomplished. FIRST will increase understanding of the chemical evolution of galaxies and stars. Development of required local oscillator is late due to late delivery of a piece of test equipment ordered from a German company. Expected to be accomplished in mid-FY 2001.

Target Assessment: Yellow

Data Source: Regular project status reports; certified by project manager, JPL.

Verification/Validation: Certified by project manager, JPL, and program executive, based on regular project status reports.

Performance Target: The prototype primary instrument for Gamma Ray Large Area Space Telescope (GLAST) will demonstrate achievement of the established instrument performance level of angular resolution of 3.5 degrees across the entire 20-MeV to 100-GeV energy range. **FY 2000 Space Science #63 (0S63)**

Actual Performance: Accomplished. This mission will observe thousands of galactic sources over a wide energy range.

A prototype GLAST instrument was constructed and successfully operated in a beam test in December 1999 and January 2000. Analysis of this data and comparison with detailed computer simulations demonstrate performance as expected. However, the metric as stated is in error. It should read "less than 3.5 degrees at 100-MeV;" it is not tested at 20-MeV.

Target Assessment: Green

Data Source: Certified by project manager, GSFC. Analysis of data from 1999 BTEM (Beam Test of Engineering Model). A paper describing BTEM measurements is in preparation for submission to a refereed scientific journal.

Verification/Validation: Certified by project manager, GSFC, and program executive.

Performance Target: Based on an overall goal of successfully launching 25 sounding rocket missions, at least 23 payloads shall successfully achieve their required altitude and orientation, and at least 21 investigators shall achieve their minimum mission success goals. **FY 2000 Space Science #65 (0S65)**

Actual Performance: Not accomplished. Sounding Rockets provide quick, low-cost access to high altitudes.

The increased programmatic costs of the privatization of sounding rocket operations in FY 1999 were not reflected in the FY 2000 budget. Seven sounding rocket missions have moved out of FY 2000 into later years, leaving a goal of 18 planned missions for the year. Sixteen missions were launched, including two failures to achieve the required altitude and orientation. Two other missions failed to meet their minimum success criteria.

BOOMERANG Telescope being readied for launch.

Target Assessment: Red

Data Source: "NASA Research Carriers Program Sounding Rocket and Balloon Projects Schedule;" certified by program executive.

Verification/Validation: Certified by program executive, based on "NASA Research Carriers Program Sounding Rocket and Balloon Projects Schedule" and program status reports.

Performance Target: Based on an overall goal of conducting 26 worldwide science and technology demonstration balloon missions, at least 23 campaigns shall successfully achieve altitude and distance, and investigators' instrumentation shall function as planned for at least 19 missions. **FY 2000 Space Science #66 (0S66)**

Actual Performance: Partially accomplished. Balloons offer a low-cost method for performing scientific investigations.

Twenty-one missions were flown in FY 2000, including two balloons that failed to achieve their required altitude and distance. For two of the missions that did achieve required altitude and distance, investigators' instrumentation failed to function as planned. It should be noted that one of the balloons that failed to reach required altitude was a test flight of a new balloon development. The result was redesign and development of the balloon, which was successfully tested in FY 2001.

Target Assessment: Red

Data Source: "NASA Research Carriers Program Sounding Rocket and Balloon Projects Schedule;" certified by program executive.

Verification/Validation: Certified by program executive, based on "NASA Research Carriers Program Sounding Rocket and Balloon Projects Schedule" and program status reports.

Objective: Explore the solar system.

Performance Target: Deliver the Mars '01 Orbiter and Lander science instruments that meet capability requirements by June 1, 2000; prelaunch Gamma Ray Spectrometer (GRS) tests shall determine abundances in known calibration sources to 10 percent accuracy. **FY 2000 Space Science #29 (0S29)**

Actual Performance: Partially accomplished. The 2001 Mars Odyssey orbiter will map the mineralogy and morphology of the Martian surface, and achieve global mapping of the elemental composition of the surface and the abundance of hydrogen just below the surface. The Mars '01 Orbiter portion of the target was accomplished; all work proceeded on schedule to support an April 2001 launch. Orbiter instruments were delivered and assembly and testing began on time. The GRS tests were also completed successfully. The Mars '01 Lander was cancelled due to program redesign after the loss of the Mars '98 spacecraft; however, the Lander instruments are to be used on the '03 Lander mission, and will be delivered in late FY 2001.

Target Assessment: Yellow

Data Source: Regular project monthly reviews, certified by program executive.

Verification/Validation: Regular monthly review, certified by program executive.

Performance Target: Assuming the Mars Surveyor program architecture is confirmed, meet the milestones for the Mars '03 instrument selection and initiate implementation of the Lander mission. Deliver engineering models of the radio-frequency subsystem and antennae for the radar sounder instrument to ESA (if ESA approves the Mars Express mis-

sion), and select the contractors for the major system elements of the Mars Surveyor '05 mission. **FY 2000 Space Science #30 (0S30)**

Actual Performance: Partially accomplished. In 2003, two powerful new Mars rovers will be on their way to the Red Planet. These rovers possess far greater mobility than the highly successful 1997 Mars Pathfinder rover. In 2005, NASA plans to launch a powerful orbiter, the Mars Reconnaissance Orbiter. This mission will focus on analyzing the surface at new scales in an effort to follow tantalizing hints of water detected in images from the Mars Global Surveyor spacecraft. Failure of the two Mars '98 spacecraft led to the Mars Surveyor Program redesign. However, milestones for Mars '03 instrument selection and Lander mission implementation have been accomplished. Engineering models for Mars Express were shipped two weeks into the new fiscal year (FY 2001). The Mars '05 mission had not yet been defined; therefore, selections were not completed.

Target Assessment: Yellow

Data Source: Regular project monthly reviews, certified by program executive.

Verification/Validation: Regular monthly review, certified by program executive.

Objective: Explore the solar system.

Performance Target: The Rosetta project will deliver the electrical qualification models for the four U.S.-provided instruments to ESA in May 2000 for integration with the Rosetta Orbiter. **FY 2000 Space Science #20 (0S20)**

Actual Performance: Accomplished. Rosetta is a European Space Agency mission that will be launched in 2003. After a long cruise phase, Rosetta will rendezvous and orbit a comet, while taking scientific measurements. A Surface Science Package will land on the comet's surface to take measurements. The U.S. is providing science instruments for the orbiter. All electrical models/electrical qualification models were delivered in (or before) May 2000.

Target Assessment: Green

Data Source: All deliveries certified at JPL Governing Program Management Council (GPMC) meetings; reported by project manager.

Verification/Validation: Certified by program executive, based on project status reports and JPL GPMC data.

Performance Target: The TIMED mission will be delivered on time for a planned May 2000 launch, within 10 percent of the planned development budget. **FY 2000 Space Science #18 (0S18)**

Actual Performance: Not accomplished. Once launched, TIMED will aid in the understanding of the basic dynamics of the region where Earth's atmosphere transitions into space. As a result of launch delays for the co-manifested payload, the JASON Project, the TIMED delivery was delayed and the planned development budget was exceeded by more than 10 percent. Budget increases were necessary to retain staff to support spacecraft launch and checkout. The TIMED spacecraft will be delivered to support the readiness of the JASON Project payload for launch.

Target Assessment: Yellow

Data Source: TIMED Launch Delay Briefing by GSFC, November 19, 1999.

Verification/Validation: Certified by program executive, based on TIMED Launch Delay Briefing by GSFC, November 19, 1999.

Performance Target: Complete the development of the Cluster-II instrument analysis software for the one U.S. and five U.S.-partnered instruments before launch and, if launch occurs in FY 2000, activate and verify the wideband data and U.S. subcomponents after launch. **FY 2000 Space Science #21 (0S21)**

Actual Performance: Accomplished. The Cluster fleet explores the space around Earth dominated by its magnetic field. The mission will help us better understand a mysterious region of the space environment that can affect spacecraft and electrical power grids on Earth. Software development was completed. The four spacecraft were launched in pairs on July 15, 2000 and August 9, 2000. All instruments have been activated on

each of the spacecraft and their science data have been captured, analyzed, and verified.

Target Assessment: Green

Data Source: Certified by project manager, GSFC.

Verification/Validation: Certified by program executive, based on project status reports.

Performance Target: The High Energy Solar Spectrographic Imager (HESSI) will be delivered in time for a planned July 2000 launch, within 10 percent of the planned development budget. **FY 2000 Space Science #22 (0S22)**

Actual Performance: Not accomplished. HESSI will explore the explosive energy release in solar flares.

Damage occurred to the space vehicle during the system vibration test. Shipment for launch occurred in January 2001.

Target Assessment: Yellow

Data Source: Certified by Explorer program manager, GSFC, and reported in MSR to the Goddard GPMC and in the HESSI Reconfirmation Review (Headquarters, August 4, 2000).

Verification/Validation: Certified by program executive, based on GPMC data and HESSI Reconfirmation Review.

Performance Target: Assuming launch and normal checkout, HESSI operations will return data to achieve at least the primary science objectives, with at least 80 percent coverage of the time allowed by orbit. **FY 2000 Space Science #23 (0S23)**

Actual Performance: Not applicable. Damage occurred to the space vehicle during the system vibration test. Launch is currently scheduled for mid-FY 2001.

Target Assessment: Yellow

Data Source: Certified by Explorer program manager, GSFC, and reported in MSR to the Goddard GPMC and in the HESSI Reconfirmation Review (August 4, 2000).

Verification/Validation: Certified by program executive, based on GPMC data and HESSI Reconfirmation Review.

Performance Target: Deliver to the Los Alamos National Laboratory in March 2000 all components for system integration and testing of the first flight system for the Two Wide-angle Imaging Neutral-atom Spectrometers (TWINS) mission. **FY 2000 Space Science #25 (0S25)**

Actual Performance: Not accomplished. TWINS will increase understanding of the solar wind. The TWINS mission is a payload of opportunity. All components were ready for acceptance as required. However, as requested, delivery has been delayed to accommodate the schedule of the non-NASA host spacecraft. Accordingly, delivery of the first flight model, including electronics box, is scheduled to occur in mid-FY 2001.

Target Assessment: Green

Data Source: Certified by Explorer program manager, GSFC, and reported in MSR to the Goddard GPMC.

Verification/Validation: Certified by program executive, based on GPMC reports.

Performance Target: The Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) will be delivered on time for a planned February 2000 launch and within 10 percent of the planned development budget. **FY 2000 Space Science #26 (0S26)**

Actual Performance: Accomplished. IMAGE is providing a new perspective on the response of the Earth's magnetosphere to the solar wind. IMAGE launched successfully on March 25, 2000, after being delivered early (in September) and under budget. Note: a six-week launch delay was caused by Red Team review and Interpoint converter alert.

Target Assessment: Green

Data Source: Certified by Explorer program manager, GSFC, and reported in MSR to the Goddard GPMC.

Verification/Validation: Certified by program executive, based on GPMC reports.

Performance Target: If launched, IMAGE will acquire critical measurements at minute time scales, returning 85 percent real-time coverage of Earth's magnetospheric changes. **FY 2000 Space Science #27 (0S27)**

Actual Performance: Accomplished. IMAGE was launched on March 25, 2000. After the 30-day checkout, the satellite acquired critical measurements at minute time scales, and returned more than 85 percent real-time coverage of Earth's magnetospheric changes.

Target Assessment: Green

Data Source: Weekly and monthly progress reports; certified by project manager.

Verification/Validation: Certified by program scientist, based on project status reports.

Performance Target: Select two Small Explorer (SMEX) missions and release a University Explorer (UNEX) Announcement of Opportunity (AO). **FY 2000 Space Science #28 (0S28)**

Actual Performance: Partially accomplished. SMEX and UNEX missions provide frequent flight opportunities for scientific investigations from space. Seven SMEX missions were selected for concept studies. Due to budget constraints, the down selection of two SMEX missions for flight has been delayed until FY 2002. Due to budget constraints, the release of the UNEX AO has been delayed indefinitely. The assessment of "red" is assigned due to the fact that the target will not be accomplished within the following fiscal year (FY 2001).

Target Assessment: Red

Data Source: Explorer AOs are publicly available at *http://research.hq.nasa.gov/code_s/code_s.cfm* as is detailed information regarding the SMEX selections.

Verification/Validation: Certified by Explorer program executive and Explorer program scientist.

Performance Target: Acquire calibrated observational data from the Japanese Yohkoh high-energy solar physics mission (including the U.S.-provided SXT) for at least 75 percent of the time permitted by tracking coverage. **FY 2000 Space Science #24 (0S24)**

Actual Performance: Accomplished. The purpose of the Yohkoh mission is to increase understanding of the birth and evolution of various forms of solar activity. Yohkoh produced calibrated observational data for approximately 99 percent of the time permitted.

Target Assessment: Green

Data Source: Monthly progress reports from U.S. Principal Investigator.

Verification/Validation: Monthly progress reports; certified by program scientist.

Performance Target: Complete Genesis spacecraft assembly and start functional testing in November 1999. **FY 2000 Space Science #31 (0S31)**

Actual Performance: Accomplished. The Genesis mission is designed to collect samples of the charged particles in the solar wind and return them to Earth laboratories for detailed analysis. It will collect samples of isotopes of oxygen, nitrogen, the noble gases, and other elements and return them to an airborne capture in the Utah desert in 2004. Such data are crucial for improving theories about the origin of the Sun and the planets, which formed from the same primordial dust cloud. Functional testing started on schedule in November 1999. However, a few spacecraft subsystems were delivered after this date, delaying completion of assembly. The metric was fully satisfied as of February 2000, within three months of the original schedule. An assessment of "yellow" was not assigned given that all work was completed well within the fiscal year.

Target Assessment: Green

Data Source: Certified by project manager, JPL, and reported at regular monthly reviews.

Verification/Validation: Certified by program executive, based on monthly review data.

Performance Target: Release an Announcement of Opportunity (AO) for the next Discovery mission. **FY 2000 Space Science #32 (0S32)**

Actual Performance: Accomplished. NASA's Discovery Program of lower-cost, highly focused scientific spacecraft represents the implementation of NASA's vision of planetary missions that are "Faster, Better, Cheaper." Three highly successful Discovery spacecraft have completed their missions: Near Earth Asteroid Rendezvous, Mars Pathfinder, and Lunar Prospector. Stardust has been launched and is now on its way to collect samples of a comet. Genesis, which will collect samples of the solar wind for analysis in Earth labs, is scheduled for launch in the summer of 2001. Upcoming missions are: The Comet Nucleus Tour, or CONTOUR, scheduled for launch in 2002; the MESSENGER mission to Mercury, scheduled for launch in 2004; and the Deep Impact mission, scheduled for launch in 2004, which will fire a projectile into a comet to expose its pristine interior ice and rock material for study by instruments on the spacecraft. The Discovery AO was released on May 19, 2000.

Target Assessment: Green

Data Source: The AO is publicly available at *http://research.hq.nasa.gov/code_s/code_s.cfm*

Verification/Validation: Certified by program executive and program scientist.

Performance Target: Successfully complete the breadboard of the imager instrument for CONTOUR and award the contract for the propulsion system after a Preliminary Design Review (PDR) that confirms the design and maintains 15 percent margins for mass and power. **FY 2000 Space Science #42 (0S42)**

Actual Performance: Accomplished. The Comet Nucleus Tour, or CONTOUR, mission is timed to encounter and study at least two comets as they make their periodic visits to the inner solar system. At each comet flyby, the spacecraft will take high-resolution pictures and perform high-resolution analyses of their composition, as well as determine the comet's precise orbit. Completed breadboarding (testing of a prototype) of the imager instrument, awarded propulsion contract, and successfully completed PDR with margins at or above 15 percent.

Target Assessment: Green

Data Source: Certified at Johns Hopkins University Applied Physics Lab (APL) Quarterly Management Meeting.

Verification/Validation: Certified by program executive based on project status reports.

Performance Target: The baseline Galileo mission ended in 1997; the target for FY 2000 is to recover at least 90 percent of playback data from at least one Galileo flyby of Io. **FY 2000 Space Science #45 (0S45)**

Actual Performance: Exceeded. Galileo is the first spacecraft to orbit a gas giant planet and the probe, carried to Jupiter on Galileo, is the first spacecraft to directly sample the atmosphere of an outer planet. The Galileo orbiter has studied the Jupiter atmosphere, the Galilean (the four largest) moons of Jupiter, and the magnetosphere. Among its discoveries in the Jupiter system thus far have been an intense radiation belt above Jupiter's cloud tops, helium in about the same concentration as the Sun, extensive and rapid resurfacing of the moon Io because of volcanism, and evidence for liquid water oceans under the moon Europa's icy surface. The mission significantly exceeded expectations for two Io encounters. For Io encounter I24, 79 percent of planned playback data was recovered. For Io encounter I25, 135 percent of planned playback data was recovered. For Io encounter I27, 227 percent of planned playback data was recovered.

Target Assessment: Blue

Data Source: Certified by project manager, JPL, through weekly project status reports.

Verification/Validation: Certified by project scientist, based on weekly project status reports and October 13, 2000 summary report. The May 19, 2000 issue of *Science*, titled "Galileo: Io Up Close," is dedicated to the results of Galileo's flybys, and includes numerous articles based on Io playback data.

Performance Target: The Mars Climate Orbiter (MCO) will aerobrake from its initial insertion orbit into a near-polar, Sun-synchronous, approximately 400-km circular orbit and will initiate mapping operations no later than May 2000,

acquiring 70 percent of the available science data and relaying to Earth 70 percent of the data transmitted at adequate signal levels by the Mars Polar Lander (MPL). **FY 2000 Space Science #40 (040)**

Actual Performance: Not accomplished. Spacecraft lost on orbit insertion in FY 1999.

Target Assessment: Red

Data Source: As reported in NASA FY 1999 Performance Report.

Verification/Validation: As reported in NASA FY 1999 Performance Report; certified by program director.

Performance Target: Mars Polar Lander (MPL) will successfully land on Mars in December 1999 and operate its science instruments for the 80-day prime mission with at least 75 percent of planned science data returned. **FY 2000 Space Science #41 (0S41)**

Actual Performance: Not accomplished; spacecraft failure on arrival at Mars. Mars Surveyor Program redesigned during FY 2000.

Target Assessment: Red

Data Source: As reported in NASA FY 1999 Performance Report.

Verification/Validation: As reported in NASA FY 1999 Performance Report; certified by program director.

Performance Target: The Mars Global Surveyor (MGS) will acquire 70 percent of science data available, conduct at least two five-day atmospheric mapping campaigns, and relay to Earth at least 70 percent of data transmitted at adequate signal levels by the Deep Space-2 (DS-2) Mars microprobes. **FY 2000 Space Science #46 (0S46)**

Actual Performance: Accomplished; MGS performed as required, and has exceeded expectations. NOTE: no DS-2 data was available to relay. MGS has acquired over 92 percent of the science data available and has conducted three campaigns (start days: December 13, May 29, and September 11). Although no DS-2 data was available to relay, the MGS relay antenna functioned properly and its beacon was detected from Earth by the Stanford 45-m antenna. Among the many discoveries MGS has made are: tantalizing evidence for recent liquid water at the Martian surface; dramatic evidence for layering of rocks that points to widespread ponding of water or lakes on Mars in its early history; and the first good estimate of the amount of water currently trapped in both Martian polar caps combined—about one and a half times the amount of ice in Greenland.

Target Assessment: Green

Data Source: Certified by project manager, JPL. Based on weekly project reports, including statistics on data recovery and atmospheric mapping campaigns. MGS science data recovered is available through links from *http://mars.jpl.nasa.gov/mgs/*

Verification/Validation: Certified by project scientist. A special issue of the *Journal of Geophysical Research*, dedicated to MGS, will be published in April 2001. The review paper by the mission manager documents MGS performance.

Performance Target: **NEAR** will successfully orbit 433 Eros and meet primary scientific objectives while not exceeding projected mission cost by more than 10 percent. **FY 2000 Space Science #16 (0S16)**

Actual Performance: Accomplished. NEAR successfully orbited Eros on February 14, 2000. The primary scientific objectives are to: (1) orbit Eros closer than 50 km, (2) measure the shape of Eros to better than 1 km and the mass to better than 20 percent, and (3) complete the first direct compositional measurements of an asteroid. All three primary scientific objectives have been met: (1) during FY 2000, NEAR orbited Eros at a distance of 35 km between July 7 and July 14, 2000, (2) as recently published in *Science*, the shape has been measured to within 100 m, and the mass is known to 0.04 percent, and (3) the first direct composition measurements of an asteroid have been published in *Science* and show that Eros is an undifferentiated asteroid. These objectives were achieved with a total mission cost 12 percent under the initial mission cost projection.

Target Assessment: Green

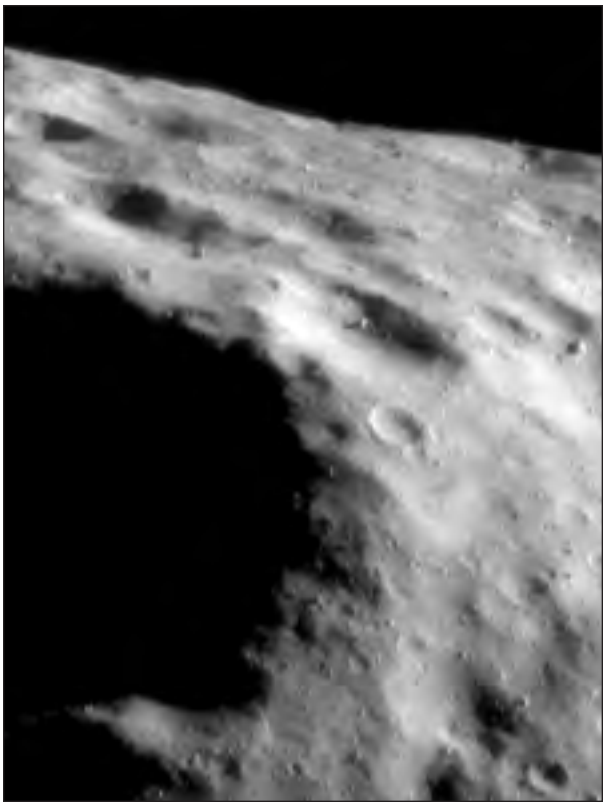
MGS image suggesting possible evidence of recent liquid water on Mars. *Science* magazine, June 30, 2000, Volume 288, Number 5475. Published by the American Association for the Advancement of Science.

Data Source: Certified by project manager, and verified through FY 2000 budget actuals.

Verification/Validation: Certified by project scientist. The primary scientific results, which satisfy the primary scientific objectives, have been peer reviewed and published in the journal *Science*.

Performance Target: Collect pixel-limited images in all Transition Region and Coronal Explorer (TRACE) wavelength bands, operating 24-hour schedules for sustained periods over 8 months. **FY 2000 Space Science #17 (0S17)**

Actual Performance: Accomplished. TRACE has provided dramatic pictures of the solar atmosphere that clearly show the effects of magnetic activity. TRACE has collected pixel-limited images in all its wavelength bands and operated 24-hour schedules for sustained periods during the entire fiscal year.



NEAR Shoemaker view of Eros' Horizon.

Target Assessment: Green

Data Source: Weekly and monthly progress reports; certified by project manager, GSFC.

Verification/Validation: Certified by program scientist, based on October 26, 2000 project status report.

Performance Target: If successfully launched, the TIMED mission will acquire global data in the mesosphere and lower thermosphere/ionosphere region globally (all the latitudes) for at least 90 days at the required spatial resolution, coverage, and accuracy and for all local solar times. **FY 2000 Space Science #19 (0S19)**

Actual Performance: Not applicable. Once launched, TIMED will provide the first global characterization of the region where the atmosphere trails off into space. However,

Life magazine coverage of TRACE "Fountains of Fire."

launch delays for the co-manifested payload, JASON, delayed the TIMED delivery and launch. The TIMED spacecraft will be delivered for launch to support the readiness of the JASON payload for launch.

Target Assessment: Yellow

Data Source: TIMED Launch Delay Briefing by GSFC, November 19, 1999.

Verification/Validation: Certified by program executive, based on TIMED Launch Delay Briefing by GSFC, November 19, 1999.

Performance Target: Collect 85 percent of data acquired from the International Solar-Terrestrial Physics (ISTP) program spacecraft and successfully execute the Wind

trajectory plan. **FY 2000 Space Science #33 (0S33)**

Actual Performance: Accomplished. ISTP is an international fleet of satellites making a coordinated study of how the Sun-Earth connects and of the impacts of solar variability on Earth. The several ISTP missions, the Solar and Heliospheric Observatory (SOHO), Wind, and Polar, have each acquired more than 99 percent of available data. The Wind trajectory plan has been executed.

Target Assessment: Green

Data Source: Weekly and monthly progress reports; certified by project manager, GSFC.

Verification/Validation: Certified by program scientist, based on October 26, 2000 project status report.

Performance Target: Cassini: Continue operations during the quiescent cruise phase without major anomalies, conduct planning for the Jupiter gravity-assist flyby, and explore early science data collection opportunities. The following in-flight activities will be completed: Instrument Checkout #2, uplink Articulation and Attitude Control Subsystem (AACS) software update with Reaction Wheel Authority capability, Command and Data Subsystem Version 8, and Saturn tour designs for selection by the Program Science Group. **FY 2000 Space Science #34 (0S34)**

Actual Performance: Accomplished. Cassini, launched in 1997, and has operated nearly flawlessly as it makes its way to Saturn, where it will begin a four-year study of the giant ringed planet and its moons starting in 2004. Cruise phase operations continued, planning accomplished, and in-flight activities completed as planned.

Target Assessment: Green

Data Source: Certified by program manager, JPL; regular status reports.

Verification/Validation: Certified by program executive, based on status reports.

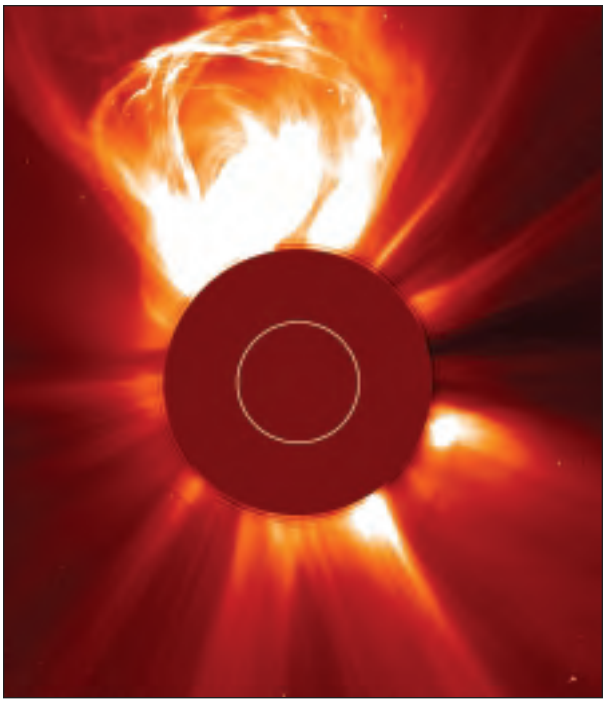
Performance Target: Capture at least 90 percent of available Ulysses science data. These will be the only data observed from outside-of-the-ecliptic plane. **FY 2000 Space Science #35 (0S35)**

Actual Performance: Accomplished. Ulysses explores the high-latitude regions of the Sun. Ulysses has captured 98.3 percent of available science data. Ulysses has passed into the south polar region of the heliosphere.

Target Assessment: Green

Data Source: Weekly and monthly progress reports; certified by JPL project representatives.

Verification/Validation: Certified by project scientist, based on October 30, 2000 status report.



SOHO image of coronal mass ejection.

Performance Target: Average 12 hours of Voyager Interstellar Mission data capture per day per spacecraft to characterize the heliosphere and the heliospheric processes at work in the outer solar system as well as the transition from the solar system to interstellar space. **FY 2000 Space Science #36 (0S36)**

Actual Performance: Partially accomplished. This mission combines the capabilities of the Voyager 1 and 2 spacecraft to explore the region where the solar system merges with the interstellar medium. While data collection was limited by time available on the DSN, the mission has succeeded at continuing to characterize the heliosphere and the heliospheric processes at work in the outer solar system as well as the transition from the solar system to interstellar space. Data capture per day averaged approximately 11 hours.

Target Assessment: Yellow

Data Source: Weekly and monthly progress reports; certified by project manager.

Verification/Validation: Certified by project scientist, based on project status reports.

Performance Target: Continue Stardust spacecraft cruise operations without major anomalies and perform interstellar dust collection for at least 36 days. **FY 2000 Space Science #37 (0S37)**

Actual Performance: Accomplished. Stardust was launched February 7, 1999. It is a comet sample return mission having the distinction of being the first sample return mission from beyond the Earth-Moon system. Stardust will collect interstellar dust, then encounter Comet P/Wild 2 in 2004, collecting comet dust and possibly imaging the nucleus at high resolution. The spacecraft will then return to Earth in 2006 to return the sample capsule. Cruise operations were continued without major anomalies and interstellar dust collection was performed for 70 days, from February 22 to May 1, 2000.

Target Assessment: Green

Data Source: Certified by project manager, JPL through regular project status reports.

Verification/Validation: Certified by program executive, based on project status reports.

Performance Target: The Fast Auroral Snapshot Explorer (FAST) will return simultaneous data from high-latitude, low-altitude magnetosphere locations in the Sun-Earth connected system through solar maximum at the required resolution and accuracy with at least 85 percent efficiency. **FY 2000 Space Science #38 (0S38)**

Actual Performance: Accomplished. FAST has found the origin of long-wavelength radio emissions from Earth's aurora region. FAST returned simultaneous data from high-latitude, low-altitude magnetosphere locations in the Sun-Earth connected system through the year at the required resolution and accuracy, with 99.5 percent efficiency.

Target Assessment: Green

Data Source: Weekly and monthly progress reports; certified by project manager, GSFC.

Verification/Validation: Certified by program scientist, based on October 26, 2000 project status report.

Performance Target: Collect and process data from the Interplanetary Monitoring Platform (IMP-8, launched in 1973), making data from at least 6 instruments available within 15 months and the magnetic field and plasma data available within 2 months. **FY 2000 Space Science #39 (0S39)**

Actual Performance: Accomplished. IMP-8 continues to accumulate a time series database useful in understanding long-term solar processes. IMP-8 collected and processed data from six instruments, making it available within 15 months. The magnetic field and plasma data were made available within two months.

Target Assessment: Green

Data Source: Certified by project scientist; regular project status reports.

Verification/Validation: Weekly and monthly progress reports; certified by program executive.

Performance Target: The Advanced Composition Explorer (ACE) will measure the composition and energy spectra of heavy nuclei in at least eight solar energetic particle events, maintain real-time solar wind data transmissions at least 90 percent of the time, measure the isotopic composition of a majority of the "primary" galactic cosmic ray elements from carbon to zinc, and provide browse parameters within three days for 90 percent of the year. **FY 2000 Space Science #48 (0S48)**

Actual Performance: Accomplished. New results on the elemental composition of solar particles and the solar wind are being achieved by ACE. In FY 2000, ACE measured the composition and energy spectra of heavy nuclei in eleven solar energetic particle events, maintained real-time solar wind data transmissions 99.9 percent of the time, measured the isotopic composition of a majority of the "primary" galactic cosmic ray elements from carbon to zinc, and provided browse parameters within three days for more than 97 percent of the year.

Target Assessment: Green

Data Source: Weekly and monthly progress reports; certified by project manager, GSFC.

Verification/Validation: Certified by program scientist, based on October 26, 2000 project status report.

Performance Target: Complete the system CDR for the New Millennium Deep Space-4 (Champollion) project before the end of FY 2000, including successful completion of the avionics subsystem CDR and the mechanical subsystem CDR. **FY 2000 Space Science #47 (0S47)**

Actual Performance: Not accomplished. The ST4/Champollion project was cancelled on July 1, 1999 because it had grown beyond the appropriate scope for a New Millennium Program mission and because the Space Science Enterprise needed resources to fund higher priority programs.

Target Assessment: Red

Data Source: FY 2000 President's Budget, Cancellation Review.

Verification/Validation: Certified by program executive.

Performance Target: The Advanced Radioactive Power Source (ARPS), which is a partnership with the Department of Energy to develop small, robust, highly efficient radioisotope power sources, will accomplish the following five objectives on time and within budget in 2000: (1) Fabricate and test 15 prototype alkali metal thermoelectric converter (AMTEC) cells by January, (2) Complete the final design of the AMTEC cells by March, (3) Complete the final design for a 75-watt ARPS by April, (4) Begin the prototype AMTEC four-cell lifetime test by April, and (5) Begin qualification unit fabrication by September. **FY 2000 Space Science #58 (0S58)**

Actual Performance: Not accomplished. Development of ARPS is important because it would allow for a more efficient power source which would use less nuclear material than current designs used on deep space missions or other missions where solar power and batteries could not provide enough energy to power spacecraft electrical systems, computers and scientific instruments. Early test results with technology demonstrations revealed chemical properties that affect lifetime and efficiency expectations for current version AMTECs. While DOE is continuing to investigate the feasibility of AMTEC, the NASA-DOE partnership has redirected its

ARPS development to use Stirling Technology Demonstration Converter's. (S-TDC). Four prototype 55 Watt electric (We) S-TDC demonstration units were delivered to NASA-GRC in August for testing. Testing will span through mid-2002. If successful, DOE will develop an RPS using the S-TDC for flight readiness in the post-2006 timeframe.

Target Assessment: Red

Data Source: Certified by project manager, JPL; regular project status reports.

Verification/Validation: Certified by program executive, based on project status reports.

Performance Target: Complete and deliver for testing Solar-B's four Electrical Engineering Models in September 2000. **FY 2000 Space Science #60 (0S60)**

Actual Performance: Not accomplished. Solar-B will study the origins of space weather and global change. As requested, delivery has been delayed until June 2001 due to the Japanese-initiated launch delay. (Note: typographical error in target; only three instruments were planned.)

Target Assessment: Yellow

Data Source: NASA/ISAS (Institute of Space and Astronautical Science, Japan)/PPARC (Particle Physics and Astronomy Research Council, UK) Tri-lateral Meeting at Praxis, Inc., Alexandria, Virginia, to re-baseline schedule; NASA/ISAS bilateral meeting at NASA Headquarters on September 6, 2000. Certified by program executive.

Verification/Validation: Certified by program executive.

Performance Target: Complete Solar Terrestrial Relations Observatory (STEREO) Phase A studies by June 2000, including the release of an AO for investigations with specific instruments and selection of the formulation phase payload. **FY 2000 Space Science #61 (0S61)**

Actual Performance: Partially accomplished. STEREO will increase understanding of the origin and development of coronal mass ejections. AO was released. Specific instruments and formulation phase payload were selected, and all included international co-investigators. Phase A studies were not completed. ITAR requirements were tightened after the AO was issued; therefore, it was not possible to establish all of the necessary letters of agreement (LOAs) with foreign governments in time to avoid delaying completion of Phase A studies until FY 2001.

Target Assessment: Yellow

Data Source: Press release No. NASA GSFC 99-131. LOAs: Database for International Agreements: *http://ossim.hq.nasa.gov/* Certified by program executive.

Verification/Validation: Certified by program executive.

Performance Target: Successfully complete a preliminary design for either the Europa Orbiter or Pluto-Kuiper Express mission (whichever is planned for earlier launch) that is shown to be capable of achieving the Category 1A science objectives with adequate cost, mass, power, and other engineering margins. **FY 2000 Space Science #64 (0S64)**

Actual Performance: Not accomplished. Pluto-Kuiper Express: Preliminary Design Review (PDR) delayed due to increases in spacecraft mass and power resulting in the need for a larger launch vehicle. Concerns were identified regarding launch vehicle qualification for launch of a spacecraft with a radioisotope power system. Mission life cycle cost estimates now exceed available budget for a planned December 2004 launch. The project is not ready to proceed into development. A stop-work order was issued in September 2000.

Europa Orbiter: PDR delayed due to concerns in spacecraft mass, power, and avionics subsystems, and launch vehicle qualification for launch of a spacecraft with a radioisotope power system. Continued engineering design for avionics and power systems. Technology developments in power and avionics subsystems are anticipated to support the FY 2008 planned launch.

Target Assessment: Red

Data Source: Regular monthly reviews, certified by program executive.

Verification/Validation: Certified by program executive.

Performance Target: The first engineering model (EM-1) of the X2000 First Delivery will be delivered in September 2000. Successful development includes the integration of all EM-1 hardware, the functional verification of delivered hardware and software, and the ability to support ongoing testing, hardware integration, and software verification for delivered software. **FY 2000 Space Science #70 (0S70)**

Actual Performance: Not accomplished. Reformulation of the Outer Planets Program has now aligned the X2000 technology activity as an advanced development of the Europa Orbiter Project. Delays to date have primarily been the result of design complexity and difficulty in integrating commercial intellectual property into the custom designs necessary to endure the space environment. In accordance with the reformulated schedule for the Europa Orbiter Project, the anticipated delivery date has moved to late FY 2002.

Target Assessment: Red

Data Source: Regular project status reports; certified by project manager, JPL.

Verification/Validation: Certified by program executive.

Objective: Discover planets around other stars.

Performance Target: The Space Interferometry Mission (SIM) System Test Bed (STB) will demonstrate, in May 2000, that a Remote Manipulator System (RMS) optical path difference can be controlled at 1.5 nanometers, operating in an emulated onorbit mode. **FY 2000 Space Science #52 (0S52)**

Actual Performance: Accomplished. SIM will identify stars that "wobble"—that is, stars that are pulled back and forth as orbiting planets move from one side of the star to the other. If SIM sees such a gravitational tug, it infers the presence of planets. The complex engineering challenges of operating several telescopes in space as a combined system, while achieving the extreme alignment precision required to perform its mission of detecting planets around nearby stars, has never been attempted before. This mission will pave the way for even larger, future space-based observatories, which can directly image planets around other stars. During FY 2000, the SIM System Test Bed-1 (STB-1) demonstrated the technology for stabilizing a space optical system to the level of 1.5 nanometers (one 50,000th the thickness of a human hair). This technology, in addition to providing a quiet enough platform for SIM to perform its planet finding mission, will help enable the next generation of large space optical systems for scientific, civil, and defense purposes. The optical path length difference was controlled to 0.7 nanometers, which surpassed the requirement of the target.

Target Assessment: Green

Data Source: Regular project status reports; certified by project manager, JPL.

Verification/Validation: Certified by program executive.

Objective: Discover planets around other stars.

Performance Target: Complete and deliver a technology development plan for the Terrestrial Planet Finder (TPF) mission by June 2000. This infrared interferometer mission is projected for a 2010 launch and requires the definition of technologies that will not be developed or demonstrated by precursor missions. **FY 2000 Space Science #54 (0S54)**

Actual Performance: Not accomplished. NASA's Terrestrial Planet Finder (TPF) will study all aspects of planets, from their formation to their final characteristics. In addition to measuring the size, temperature, and placement of Earth-sized and other planets, TPF will look for gases such as carbon dioxide, water vapor, ozone, and methane that would indicate that a far-away planet could—or even does—support life. TPF will find the tiny, faint planets around distant stars by reducing the glare of their parent stars a hundred-thousand times, and taking pictures of planetary systems as far away as 50 light years. With pictures a hundred times more detailed than those of the Hubble Space Telescope, TPF will also allow us to study the black hole at the center of the Milky Way and other exciting phenomena in the universe. The projected launch date for TPF was moved out two years to 2012 and the budget guidelines were readjusted by NASA Headquarters. As a result, the pre-project activities were replanned by JPL. Architecture definition studies were initiated in the second quarter of FY 2000 and the technology roadmap development was postponed until after these studies are completed in the second quarter of FY 2002. As a

result of Headquarters decisions to delay the TPF mission and the project replanning, the technology development roadmap will not be completed until FY 2002.

Target Assessment: Red

Data Source: Regular project status reports; certified by project manager, JPL.

Verification/Validation: Certified by program executive.

Performance Target: Development of the interferometer program for connecting the twin Keck 10-meter telescopes with an array of four 2-meter class outrigger telescopes will be tested by detecting and tracking fringes with 2 test siderostats at 2- and 10-micron wavelengths. **FY 2000 Space Science #55 (0S55)**

Actual Performance: Not accomplished. To expand the capabilities of the world's largest telescopes even further, NASA's Origins Program is in the process of connecting the twin Keck telescopes. By combining the light paths from each twin, astronomers will gain the capability of a single telescope the size of the distance between them—a process called interferometry. This will be approximately the equivalent of an 85-meter mirror—almost the size of a football field. The Keck interferometer will be used to directly detect planets around other stars as well as other exotic and as-yet unseen cosmic objects. Development of the Keck Interferometer is taking longer than originally planned. The first detection and tracking of "fringes," or light waves gathered by the two telescopes (at 2 microns) while tracking a star, was successfully demonstrated with the siderostats, or small test telescopes, in February 2001. This was a critical end-to-end test needed before attempting to take light from the twin Keck telescopes (instead of using the siderostats) and obtain fringes—using the two Kecks. The first Keck-Keck fringes are expected in mid-FY 2001. The siderostats will continue to be used to check out new interferometer instruments before using the two Kecks. The first light waves at 10 microns obtained using the test telescopes with an instrument to null, or block, starlight to enable planet detection, are expected in September 2001.

Target Assessment: Yellow

Data Source: Regular project status reports; certified by project manager.

Verification/Validation: Certified by program executive.

Objective: Search for life beyond Earth.

Performance Target: The Europa Orbiter project will successfully complete a PDR in March 2000 and will begin the integration and test of the Avionics Engineering Model in July 2000. **FY 2000 Space Science #56 (0S56)**

Actual Performance: Not accomplished. If liquid water were to exist on Jupiter's moon Europa, it would not be unreasonable to speculate on the existence of life there, perhaps forming near undersea volcanic vents if they exist there. Planning has begun on a mission to send a spacecraft to Europa to measure the thickness of the surface ice and to detect an underlying liquid ocean if it exists. Using an instrument called a radar sounder to bounce radio waves through the ice, the Europa Orbiter sciencecraft would be able to detect an ice-water interface, perhaps as little as 1 km below the surface. A PDR was delayed due to concerns in spacecraft mass, power, and avionics subsystems, and launch vehicle qualification for launch of a spacecraft with a radioisotope power system. Engineering design for avionics and power systems continued. Technology developments in power and avionics subsystems are anticipated to support the FY 2008 planned launch.

Target Assessment: Red

Data Source: Regular monthly reviews, certified by program executive.

Verification/Validation: Certified by program executive.

Goal: Develop new, critical technologies to enable innovative and less costly mission and research concepts.

Objective: Develop innovative technologies for Enterprise missions and for external customers.

Performance Target: Information Systems R&T will demonstrate the search, discovery, and fusion of multiple data products at a major science meeting. Accomplish and document the infusion of five information systems' R&T efforts into flight

projects or the broad research community. Space science data services shall be acknowledged as enabling for two interdisciplinary collaborations. **FY 2000 Space Science #49 (0S49)**

Actual Performance: Accomplished. Infusion of information systems' R&T efforts included: (1) Computational tools developed under Applied Information Systems Research (AISRP) used for Balloon Observations of Millimetric Extragalactic Radiation and Geophysics (BOOMERANG) and Millimeter Anisotropy Experiment Imaging Array (MAXIMA) data analysis, (2) Physics based modeling/simulation used for Miniature Integrated Camera Spectrometer (MICAS) camera on DS-1, (3) Pixon method image reconstruction used for Chandra and other flight mission data, (4) Precision mining of hyperspectral data applied for Mars mission data analysis, (5) SkyView virtual telescope capability incorporated into mainstream High Energy Astrophysics Science Archive Research Center (HEASARC) data center services, and (6) Science expert assistant adopted by the Space Telescope Science Institute (STScI) for production use with HST observing program. Data products successfully demonstrated at American Astronomical Society (AAS) and American Geophysical Union (AGU) meetings. Interdisciplinary collaborations included: (1) Digital Sky project constructed first portable services for positional cross-comparison of large catalogs, and (2) Direct links to Extreme Ultraviolet Explorer (EUVE) and the Roentgen Satellite (ROSAT) data physically stored at HEASARC from Optical/UV SARC at STScI to enable easy cross-correlation between UV/optical and x-ray data.

Target Assessment: Green

Data Source: Periodic project status reports; professional society meeting minutes and reports.

Verification/Validation: Certified by program executive.

Performance Target: The Remote Exploration and Experimentation element of the HPCC program will demonstrate software-implemented fault tolerance for science teams' applications on a first-generation embedded computing test bed, with the applications' sustained performance degraded by no more than 25 percent at fault rates characteristic of deep space and low-Earth orbit. **FY 2000 Space Science #50 (0S50)**

Actual Performance: Not accomplished. Delivery of the first-generation embedded computing test bed delayed due to hardware problems; delivered in November 2000. Demonstration expected in late FY 2001.

Target Assessment: Yellow

Data Source: Periodic project status reports; certified by project manager, JPL.

Verification/Validation: Certified by program executive.

Performance Target: In April 2000, the Center for Integrated Space Microelectronics (CISM) will deliver to the X2000 First Delivery project the first engineering model of an integrated avionics system that includes the functionality of command and data handling, attitude control, power management and distribution, and science payload interface. The system will be used on the Europa Orbiter and other missions. **FY 2000 Space Science #57 (0S57)**

Actual Performance: Not accomplished. Although some elements of command and data handling were delivered, the remainder of the activity represented by the target is now encompassed by an advanced development effort of the Europa Orbiter Project, under the reformulated Outer Planets Program. This reformulation has now aligned the X2000 technology activity as an advanced development of the Europa Orbiter Project (Europa Orbiter represents the first use of X2000 technology). CISM has been realigned to development of lower level technology (Technology Readiness Levels 3 to 6). Completion of the effort represented by the target is anticipated in late FY 2002.

Target Assessment: Red

Data Source: Project status reports, certified by project manager, JPL.

Verification/Validation: Certified by program executive.

Goal: Contribute measurably to achieving the science, math, and technology education goals of our Nation, and share widely the excitement and inspiration of our missions and discoveries.

Objective: Incorporate education and enhanced public understanding of science as integral components of Space Science missions and research.

Performance Target: Successful achievement of at least seven of the following eight objectives will be made. (1) Each new Space Science mission will have a funded education and public outreach (E/PO) program. (2) By the end of FY 2000, 10 percent of all Space Science research grants will have an associated education and outreach program underway. (3) Twenty-six states will have Enterprise-funded education or outreach programs planned or underway. (4) At least five research, mission development/operations, or education programs will have been planned/undertaken in Historically Black Colleges and Universities (HBCU), Hispanic Serving Institutions, or Tribal Colleges, with at least one project underway in each group. (5) At least three national and two regional educational or outreach conferences will be supported with a significant Space Science presence. (6) At least three exhibits or planetarium shows will be on display. (7) An online directory providing enhanced access to major Space Science-related products and programs will be operational by end of the fiscal year. (8) A comprehensive approach to assessing the effectiveness and impact of the Space Science education and outreach efforts will be under development, with a pilot test of the evaluation initiated. **FY 2000 Space Science #67 (0S67)**

Actual Performance: Accomplished. Seven out of the eight specific objectives were achieved or substantially exceeded. The only objective not met involved the number of research grants having an associated education and public outreach component underway. Representative accomplishments for the seven objectives include the following:

- All missions have a funded E/PO component as a consequence of Office of Space Science (OSS) policy. Mission budgets have one to two percent of their total funds set aside for E/PO by the project managers, E/PO leads are in place for each mission, E/PO plans are being developed, and an increasing number of products and programs are in place.
- E/PO programs are now in place in well over twenty-six states. For example, in conjunction with the New Millennium E/PO program, Space Place exhibits are now located in science museums, planetariums, libraries, and aquariums in forty-four states. Solar System Educator Fellows/Ambassadors are now carrying out programs in more than thirty states. These two activities represent just a small fraction of the total portfolio of activities now underway. Many programs now underway are readily accessible through the Internet, thereby becoming a resource for the entire community.
- As a consequence of the results of the selection of programs for the Space Science Minority University Initiative, firm plans are now in place for programs in at least five minority institutions, with at least one underway at a Historically Black College or University, a Hispanic Serving Institution, and a Tribal College. Additional activities underway in such institutions include research grants to HBCUs, operation of the FUSE mission through a ground station at the University of Puerto Rico-Mayaguez, and the selection of an HBCU for one of the new Explorer Studies, to be undertaken in the SMEX Program.
- There was a significant Space Science presence, as shown through the presence of major exhibits, presentation of workshops for teachers, or major speakers at a very large number of national and regional education conferences.

National conferences with such a major space science presence in FY 2000 included:

- The Tampa meeting of the Association of Science and Technology Centers
- The Orlando meeting of the National Science Teachers Association
- The Chicago meeting of the National Council of Teachers of Mathematics

Regional meetings receiving such coverage included:

- The Idaho Science Teachers Association meeting
- The Michigan State Science Teachers Association meeting
- The California Science Teachers Association meeting

A grand total of more than thirty education and outreach conferences were covered. The minimum requirement was substantially exceeded.

Major planetarium shows and science exhibits now on display across the country include:

- The Space Weather Traveling Exhibit (Denver, Sacramento, Baltimore)
- The 5,000-square foot version of the Hubble Space Telescope Traveling Exhibit (Chicago, Houston)

- The 2,000-square foot version of the HST Traveling Exhibit (Saginaw)
- MarsQuest (Birmingham)
- Journey to the Edge of Space and Time (Boston, Philadelphia)

The requirement was substantially exceeded.

- The online Resource Directory, containing more than one hundred items, is now accessible at: *http://teach-spacescience.stsci.edu* Upgrades to this initial version are planned for next year.
- A comprehensive evaluation effort is now underway under the leadership of the Program and Evaluation and Research Group at Lesley College in Cambridge, Massachusetts. An initial written report describing the pilot effort (and the first results) to assess the effectiveness of the OSS E/PO support network was received in June 2000, and additional work has now begun to develop approaches to assessing the educational quality and effectiveness of the OSS E/PO program.

Target Assessment: Green

Data Source: Direct reports from participants and compilation of information obtained through the OSS E/PO tracking and reporting system.

Verification/Validation: Certified by Assistant Associate Administrator, Education and Outreach. All FY 2000 data has been assembled and is available for review in the OSS E/PO FY 2000 Annual Report.

Goal: Support all goals.

Objective: Support all objectives.

Performance Target: Conduct research and analysis. **FY 2000 Space Science #68 (0S68)**

Actual Performance: Accomplished. Conducted through over 1,500 funded research and analysis investigations, selected through peer-review process involving over 200 outside reviewers serving on more than 30 panels, which results in awards for well-specified research and analysis relevant to the OSS Strategic Plan.

SOFIA will involve educators directly in its research programs by flying them on the observatory itself and centering its education and public outreach programs on these opportunities.

Target Assessment: Green

Data Source: Division procurement, program tracking, and peer review process documents.

Verification/Validation: Certified by Director, Research Program Management Division.

Objective: Support all objectives.

Performance Target: Conduct data analysis. **FY 2000 Space Science #69 (0S69)**

Actual Performance: Accomplished. Conducted through over 500 funded research and analysis investigations, selected through peer review process involving over 150 outside reviewers serving on more than 20 panels, which results in awards for well-specified data analysis relevant to the OSS Strategic Plan.

Target Assessment: Green

Data Source: Division procurement, program tracking, and peer review process documents.

Verification/Validation: Certified by Director, Research Program Management Division.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Solve mysteries of the universe.	9S1	Successfully launch 7 spacecraft, within 10% of budget, on average.	Blue				Target eliminated.
	9S2	Measure the Hubble constant within an accuracy of about 10 percent, as compared to previous measurements that differ among themselves by a factor of 2. (R&A)	Green				Target eliminated.
	9S3	Record 25 images and spectra at a resolution of better than an arcsecond, 5 to 10 times sharper than images gathered earlier by the Einstein Observatory. (CXO)	Green	0S1	The Chandra X-ray Observatory (formerly AXAF) instrument will meet nominal performance expectations, and science data will be taken with 70% efficiency, with at least 90% of science data recovered on the ground.	Green	Observatory continues to operate successfully, exceeding efficiency and data recovery expecta-tions.
	9S4	Record data on approximately 12 compact stellar objects with sensitivity 50 times greater than the Einstein Observatory. (CXO)	Green				Target consolidated into 0S1.
				0S3	Complete final integration and test of the Gravity Probe-B science payload with the spacecraft in August 2000.	Yellow	New target.
				0S4	Successfully install and activate 3 key Hubble upgrades during the third servicing mission: flight computer, advanced camera, and solar arrays. Maintain an average on-target pointing efficiency of 35% during FY 2000 operations before they are interrupted for the third servicing mission, presently scheduled for May 2000.	Yellow	New target.
				0S43	Complete the SOFIA 747 Section 46 mockup test activity during June 2000, with no functional test discrepancies that would invalidate CDR-level designs and cause significant design rework, with attendant cost and schedule impact.	Green	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Solve mysteries of the universe (continued).				OS5	Deliver the SIRTF IRAC, MIP, and IRS instruments during April 2000. The instruments shall perform at their specified levels at delivery.	Yellow	New target.
				OS6	Prepare the ISDC for data archiving and prepare instrument analysis software for the spectrometer on INTEGRAL (SPI) instrument within 10% of estimated cost.	Green	New target.
				OS7	Assemble and successfully test the breadboard cooler for ESA's Planck mission in April 2000.	Yellow	New target.
				OS8	Deliver the GALEX science instrument from JPL to the Space Astrophysics Laboratory at Caltech during April 2000 for science calibration. The instrument will be fully integrated, functionally tested, and environmentally qualified at the time of the scheduled delivery.	Yellow	New target.
				OS9	Begin system-level environmental testing of the MAP spacecraft during July 2000.	Green	New target.
				OS11	The baseline mission of the CGRO ended in 1996; the target for FY 2000 is to continue to operate those instruments not dependent on expended consumables (OSSE, BATSE, and COMPTEL) at an average efficiency of at least 60%.	Green	New target.
				OS12	The 3-year FUSE mission will complete at least one-third of the observations needed for its minimum science program, with 6 of the 8 instrument performance parameters being met.	Green	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Solve mysteries of the universe (continued).				OS15	The prime mission of SAMPEX ended in 1995; the FY 2000 target is to obtain at least 60% data coverage from at least 3 of SAMPEX's 4 instruments.	Green	New target.
	9S5	Observe physical phenomena 25,000 times closer to the event horizon of black holes than permitted with optical wavelength measurements.(RXTE)	Green	OS2	The baseline RXTE mission ended in 1997; the target for FY 2000 is to operate at least 3 of the 5 instruments at an efficiency of 45%, with 95% data recovery; All Sky Monitor data will be posted on the web within 7 days, and Proportional Counter Array and High-Energy X-ray Timing Experiment data will be released within 60 days.	Green	RXTE continued to operate nominally from FY 1999 to FY 2000. The science instruments continued to return excellent data, with no degradation in performance. RXTE observations of neutron stars and black holes continued to yield a wealth of new information concerning both the nature of these enigmatic objects as well as tests of the predictions of general relativity under the extremes of gravity, temperature, and magnetic fields found in the region surrounding these objects. Both the total number of observations of sources and the quality of the resulting data obtained with the RXTE science instruments continued at a high level from FY 1999 though FY 2000.
				OS14	If launched, activate the XRS and XIS instruments on the Japanese Astro-E spacecraft after launch and collect at least 90% of the XRS and XIS data.	Red	New target.
				OS53	Complete the NGST Developmental Cryogenic Active Telescope Test Bed (DCATT) phase 1, measure ambient operation with off-the-shelf components, and make final preparations for phase 2, the measurement of cold telescope operation with selected "flight-like" component upgrades.	Red	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Solve mysteries of the universe (continued).				OS62	Demonstrate performance of the Superconductor-Insulator-Superconductor (SIS) mixer to at least 8hv/k at 1,120 GHz and 10hv/k at 1,200 GHz. The U.S. contribution to the ESA FIRST is the heterodyne instrument, which contains the SIS receiver.	Yellow	New target.
				OS63	The prototype primary instrument for GLAST will demonstrate achievement of the established instrument performance level of angular resolution of 3.5 degrees across the entire 20-MeV to 100-GeV energy range.	Green	New target.
				OS65	Based on an overall goal of successfully launching 25 sounding rocket missions, at least 23 payloads shall successfully achieve their required altitude and orientation, and at least 21 investigators shall achieve their minimum mission success goals.	Red	New target.
				OS66	Based on an overall goal of conducting 26 worldwide science and technology demonstration balloon missions, at least 23 campaigns shall successfully achieve altitude and distance, and investigators' instrumentation shall function as planned for at least 19 missions.	Red	New target.
Explore the solar system.				OS29	Deliver the Mars '01 Orbiter and Lander science instruments that meet capability requirements by June 1, 2000; prelaunch Gamma Ray Spectrometer (GRS) tests shall determine abundances in known calibration sources to 10% accuracy.	Yellow	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Explore the solar system (continued).				OS30	Assuming the Mars Surveyor program architecture is confirmed, meet the milestones for the Mars '03 instrument selection and initiate implementation of the Lander mission. Deliver engineering models of the radio-frequency subsystem and antennae for the radar sounder instrument to ESA (if ESA approves the Mars Express mission), and select the contractors for the major system elements of the Mars Surveyor '05 mission.	Yellow	New target.
				OS20	The Rosetta project will deliver the electrical qualification models for the 4 U.S.-provided instruments to ESA in May 2000 for integration with the Rosetta Orbiter.	Green	New target.
				OS18	The TIMED mission will be delivered on time for a planned May 2000 launch, within 10% of the planned development budget.	Yellow	New target.
				OS21	Complete the development of the Cluster-II instrument analysis software for the 1 U.S. and 5 U.S.-partnered instruments before launch and, if launch occurs in FY 2000, activate and verify the wideband data and U.S. subcomponents after launch.	Green	New target.
				OS22	HESSI will be delivered in time for a planned July 2000 launch, within 10% of the planned development budget.	Yellow	New target.
				OS23	Assuming launch and normal checkout, HESSI operations will return data to achieve at least the primary science objectives, with at least 80% coverage of the time allowed by orbit.	Yellow	New target.
				OS25	Deliver to the Los Alamos National Laboratory in March 2000 all components for system integration and testing of the first flight system for the TWINS mission.	Green	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Explore the solar system (continued).				OS26	IMAGE will be delivered on time for a planned February 2000 launch and within 10% of the planned development budget.	Green	New target.
				OS27	If launched, IMAGE will acquire critical measurements at minute time scales, returning 85% real-time coverage of Earth's magnetospheric changes.	Green	New target.
				OS28	Select two SMEX missions and release a UNEX AO.	Red	New target.
				OS24	Acquire calibrated observational data from the Japanese Yohkoh high-energy solar physics mission (including the U.S.-provided SXT) for at least 75% of the time permitted by tracking coverage.	Green	New target.
				OS31	Complete Genesis spacecraft assembly and start functional testing in November 1999.	Green	New target.
				OS32	Release an AO for the next Discovery mission.	Green	New target.
				OS42	Successfully complete the breadboard of the imager instrument for CONTOUR and award the contract for the propulsion system after a PDR that confirms the design and maintains 15% margins for mass and power.	Green	New target.
	9S13	Successfully complete and receive scientific data from at least 8 of 10 planned data-taking encounters with Europa.	Green	OS45	The baseline Galileo mission ended in 1997; the target for FY 2000 is to recover at least 90% of playback data from at least one Galileo flyby of Io. (Galileo)	Blue	Galileo continues to obtain scientifically valuable data on Io and other Jovian moons. Playback data regularly exceeds the 90% metric, with Galileo returning in excess of 90% of playback data from two flybys of Io in FY 2000.
	9S14	Bring the total mapping coverage to about 1% of the surface at about 30-meter resolution, and multispectral coverage distributed over 50% of the surface at lower resolution. (Galileo)		Green			Target consolidated into OS45.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Explore the solar system (continued).				OS40	The MCO will aerobrake from its initial insertion orbit into a near-polar, Sun-synchronous, approximately 400-km circular orbit and will initiate mapping operations no later than May 2000, acquiring 70% of the available science data and relaying to Earth 70% of the data transmitted at adequate signal levels by MPL.	Red	New target.
				OS41	MPL will successfully land on Mars in December 1999 and operate its science instruments for the 80-day prime mission with at least 75% of planned science data returned.	Red	New target.
	9S15	Achieve the final science orbit. (MGS)	Green	OS46	MGS will acquire 70% of science data available, conduct at least two 5-day atmospheric mapping campaigns, and relay to Earth at least 70% of data transmitted at adequate signal levels by the Deep Space-2 Mars microprobes.	Green	MGS continues to meet or exceed all operational and scientific metrics adding to the database of Mars research. All instruments continue to operate and mission operations continue in an efficient manner.
	9S19	Measure the topography with 10-meter precision, about 100 times more accurate than previous. (MGS)	Blue				Target consolidated into OS46.
	9S20	Provide high-resolution 1.5-meter imaging data, 10 times more detailed than the best imaging from the 1976 Viking mission. (MGS)	Green				Target consolidated into OS46.
	9S21	Provide the first thermal infrared spectrometry of the planet. (MGS)	Green				Target consolidated into OS46.
	9S6	Orbit Eros closer than 50 kilometers, 20-30 times closer than previous asteroid flybys. (NEAR)	Yellow	OS16	NEAR will successfully orbit 433 Eros and meet primary scientific objectives while not exceeding projected mission cost by more than 10%.	Green	NEAR continues to orbit Eros and regularly exceeds its primary scientific objectives while operating within budget and adding to our knowledge of the solar system.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Explore the solar system (continued).	9S7	Measure the shape of Eros to an accuracy of 1 km or better, about 10 times better than previous measurements, and measure the asteroid's mass to an accuracy of 20%. (NEAR)	Green				Target consolidated into 0S16.
	9S8	Complete the first direct compositional measurements of an asteroid. (NEAR)	Yellow				Target consolidated into 0S16.
	9S9	Map the 75 to 80% of the Moon's surface not accessible during the Apollo missions conducted from 1969 to 1972. (Lunar Prospector)	Green				Target eliminated.
	9S10	Provide definitive measurements of the weak lunar magnetic field. (Lunar Prospector)	Green				Target eliminated.
	9S11	Provide these data with spatial resolution five times better than were collected from the Yohkoh Soft X-ray Telescope. (TRACE)	Green	0S17	Collect pixel-limited images in all TRACE wavelength bands, operating 24-hour schedules for sustained periods over eight months.	Green	Continues to produce outstanding science results. The results from TRACE have proven to have popular appeal and thus have received a significant amount of attention beyond the science community.
				0S19	If successfully launched, the TIMED mission will acquire global data in the mesosphere and lower thermosphere/ionosphere region globally (all the latitudes) for at least 90 days at the required spatial resolution, coverage, and accuracy and for all local solar times.	Yellow	New target.
				0S33	Collect 85% of data acquired from the ISTP program spacecraft and successfully execute the Wind trajectory plan.	Green	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Explore the solar system (continued).				OS34	Continue Cassini operations during the quiescent cruise phase without major anomalies, conduct planning for the Jupiter gravity-assist flyby, and explore early science data collection opportunities. The following in-flight activities will be completed: Instrument Checkout #2, uplink Articulation and Attitude Control Subsystem (AACS) software update with Reaction Wheel Authority capability, Command and Data Subsystem Version 8, and Saturn tour designs for selection by the Program Science Group.	Green	New target.
				OS35	Capture at least 90% of available Ulysses science data. These will be the only data observed from outside-of-the-ecliptic plane.	Green	New target.
				OS36	Average 12 hours of Voyager Interstellar Mission data capture per day per spacecraft to characterize the heliosphere and the heliospheric processes at work in the outer solar system as well as the transition from the solar system to interstellar space.	Yellow	New target.
				OS37	Continue Stardust spacecraft cruise operations without major anomalies and perform interstellar dust collection for at least 36 days.	Green	New target.
				OS38	FAST will return simultaneous data from high-latitude, low-altitude magnetosphere locations in the Sun-Earth connected system through solar maximum at the required resolution and accuracy with at least 85% efficiency.	Green	New target.
				OS39	Collect and process data from IMP-8, launched in 1973, making data from at least 6 instruments available within 15 months and the magnetic field and plasma data available within 2 months.	Green	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Explore the solar system (continued).				OS48	ACE will: measure the composition and energy spectra of heavy nuclei in at least eight solar energetic particle events; maintain real-time solar wind data transmissions at least 90% of the time; measure the isotopic composition of a majority of the "primary" galactic cosmic ray elements from carbon to zinc; and provide browse parameters within 3 days for 90% of the year.	Green	New target.
				OS47	Complete the system CDR for the New Millennium Deep Space-4 (Champollion) project before the end of FY 2000, including successful completion of the avionics subsystem CDR and the mechanical subsystem CDR.	Red	New target.
				OS58	The ARPS, which is a partnership with the Department of Energy to develop small, robust, highly efficient radioisotope power sources, will accomplish the following five objectives on time and within budget in 2000: fabricate and test 15 prototype AMTEC cells by January, complete the final design of the AMTEC cells by March, complete the final design for a 75-watt ARPS by April, begin the prototype AMTEC four-cell lifetime test by April, and begin qualification unit fabrication by September.	Red	New target.
				OS60	Complete and deliver for testing Solar-B's four Electrical Engineering Models in September 2000.	Yellow	New target.
				OS61	Complete STEREO Phase A studies by June 2000, including the release of an AO for investigations with specific instruments and selection of the formulation phase payload.	Yellow	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Explore the solar system (continued).				OS64	Successfully complete a preliminary design for either the Europa Orbiter or Pluto-Kuiper Express mission (whichever is planned for earlier launch) that is shown to be capable of achieving the Category 1A science objectives with adequate cost, mass, power, and other engineering margins.	Red	New target.
				OS70	EM-1 of the X2000 First Delivery will be delivered in September 2000. Successful development includes the integration of all EM-1 hardware, the functional verification of delivered hardware and software, and the ability to support ongoing testing, hardware integration, and software verification for delivered software.	Red	New target.
Discover planets around other stars.	9S12	Assemble and lab-test the interferometer beam combiner. This state-of-the-art system will approximately double observational efficiency by using a new approach to fringe detection. (Keck)	Green	OS55	Development of the interferometer program for connecting the twin Keck 10-meter telescopes with an array of four two-meter class outrigger telescopes will be tested by detecting and tracking fringes with two test siderostats at two- and ten-micron wavelengths.	Yellow	Development of the Keck Interferometer is taking longer than originally planned. The first detection and tracking of fringes, or light waves, at 2 microns with the siderostats was accomplished in February 2001. The first 10-micron fringes using the nuller instrument with the siderostats will be detected in September 2001.
				OS52	The SIM STB will demonstrate, in May 2000, that Remote Manipulator System optical path difference can be controlled at 1.5 nanometers, operating in an emulated onorbit mode.	Green	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Discover other planets around other stars (continued).				OS54	Complete and deliver a technology development plan for the TPF mission by June 2000. This infrared interferometer mission is projected for a 2010 launch and requires the definition of technologies that will not be developed or demonstrated by precursor missions.	Red	New target.
Search for life beyond Earth.				OS56	The Europa Orbiter project will successfully complete a PDR in March 2000 and will begin the integration and test of the Avionics Engineering Model in July 2000.	Red	New target.
	9S17	Initiate Institute operations by linking up to 8 institutions and engaging approximately 50 investigators. (Astrobiology Institute)	Green				Target eliminated.
Improve the reliability of space weather forecasting.	9S22	Achieve complete coverage (maximum and minimum) of the solar cycle, an increase from 35 percent. (Space Physics fleet of spacecraft)	Green				Target eliminated.
Develop innovative technologies for Enterprise missions and external customers.	9S23	Demonstrate an electric ion propulsion system with specific impulse 10 times greater than chemical propulsion systems. (DS 1)	Blue				Target eliminated.
	9S24	Demonstrate an improvement in measurement precision for optical path lengths in laser light to the 100-picometer (million-millionth of a meter) range. (Micro-Arcsecond Metrology Test Bed)	Yellow				Target eliminated.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Develop innovative technologies for Enterprise missions and external customers.	9S25	Demonstrate an advanced robotic manipulator with an order of magnitude performance improvement compared to the manipulator used on Viking in 1976. (Robotic Manipulator, Mars Polar Lander)	Yellow				Target eliminated.
				OS49	Information Systems R&T will demonstrate the search, discovery, and fusion of multiple data products at a major science meeting. Accomplish and document the infusion of five information systems R&T efforts into flight projects or the broad research community. Space science data services shall be acknowledged as enabling for two interdisciplinary collaborations.	Green	New target.
				OS50	The Remote Exploration and Experimentation element of the HPCC program will demonstrate software-implemented fault tolerance for science teams' applications on a first-generation embedded computing test bed, with the applications' sustained performance degraded by no more than 25% at fault rates characteristic of deep space and low-Earth orbit.	Yellow	New target.
				OS57	In April 2000, the Center for Integrated Space Microelectronics will deliver to the X2000 First Delivery project the first engineering model of an integrated avionics system that includes the functionality of command and data handling, attitude control, power management and distribution, and science payload interface. The system will be used on the Europa Orbiter and other missions.	Red	New target.

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Incorporate education and enhanced public understanding of science as integral components of space science missions and research.	9S26	Account for 4 percent of the 150 "most important science stories" in the annual review by *Science News*.	Green				Target eliminated.
	9S27	Account for no less than 25% of total contributions to the college textbook *Astronomy: From the Earth to the Universe.*	Green				Target eliminated.
	9S28	Each new Space Science Enterprise mission initiated in FY 1999 will have a funded education and outreach program.	Green	OS67	Successful achievement of at least 7 of the following 8 objectives will be made. (1) Each new Space Science mission will have a funded education and outreach program. (2) By the end of FY 2000, 10% of all Space Science research grants will have an associated education and outreach program underway. (3) 26 states will have Enterprise-funded education or outreach programs planned or underway. (4) At least 5 research, mission development/ operations, or education programs will have been planned/undertaken in Historically Black Colleges and Universities, Hispanic Serving Institutions, or Tribal Colleges, with at least one project underway in each group. (5) At least 3 national and 2 regional educational or outreach conferences will be supported with a significant Space Science presence. (6) At least 3 exhibits or planetarium shows will be on display. (7) An online directory providing enhanced access to major Space Science-related products and programs will be operational by end of the fiscal year. (8) A comprehensive approach to assessing the effectiveness and impact of the Space Science education and outreach efforts will be under	Green	Progress on each objective is as follows: (1) Each new Space Science mission in both FY 1999 and FY 2000 had had a funded education and outreach program. This requirement is now established OSS policy. (2) This was not a goal for FY 1999 and it was not met for FY 2000. Developing plans to correct this deficiency continues to be a priority. The FY 1999 goal of completing a national organized network of E/PO contacts was fully met and completed by the end of FY 1999. FY 2000 goals 3 through 8 are all activities expected to be carried out with the assistance of this network; thus, they replace and extend the FY 1999 goal. (3) Exceeded in FY 2000. E/PO programs are now underway in well over 26 states. For example, Space Place exhibits developed by the New Millennium E/PO Program are in more than 40 states, and Solar System Educator

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Incorporate education and enhanced public understanding of science as integral components of space science missions and research. (continued)					(continued) development, with a pilot test of the evaluation initiated.		(continued) Fellows/Ambassadors are carrying out programs in more than 30 states. (4) Exceeded in FY 2000. As a result of the Space Science Minority University Initiative, space science activities are now in place at 15 minority universities, including 6 HBCU's, 3 HSI's, and 3 TCU's. In addition, an HSI (University of Puerto Rico at Mayagüez) is providing ground station operations for the FUSE mission, and an HBCU (Hampton University) has been selected in the study phase for new SMEX missions. (5) Exceeded in FY 2000. More than 30 education and outreach conferences were supported, including major national conferences such as the Association of Science and Technology Centers, the National Science Teachers Association, and the National Council of Teachers of Mathematics, and copious regional conferences. (6) Exceeded in FY 2000. Major exhibits/planetarium shows now on national tour include Space Weather, Hubble Space Telescope (2 versions), MarsQuest, and Journey to the Edge of Space and Time. (7) Met in FY 2000. The NASA Space Science Education Resource Directory was made

SPACE SCIENCE ENTERPRISE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Incorporate education and enhanced public understanding of science as integral components of space science missions and research. (continued)							(continued) available to educators in September 2000. (8) Met in FY 2000. A comprehensive evaluation effort is being led by the Program and Evaluation and Research Group of Lesley College, with an initial report on the pilot evaluation effort issued in June 2000.
	9S29	The Space Science Enterprise will complete an organized network of contacts by the end of FY 1999 to work with educators and space scientists to formulate and implement space science education and outreach programs. This network will be available to every State in the United States.	Green				Target consolidated into 0S67.
Multi-theme/support all objectives.				0S68	Conduct research and analysis.	Green	New target.
				0S69	Conduct data analysis.	Green	New target.

Aerospace Technology Enterprise

FY 2000 Aerospace Technology

Mission: Maintain U.S. preeminence in aerospace research and technology.

The Aerospace Technology Enterprise pioneers the identification, development, verification, transfer, application, and commercialization of high-payoff aeronautics and space transportation technologies. The Enterprise plays a key role in the Government's policy of maintaining a safe, environmentally sound, and efficient national aviation system and the policy of developing safer, more affordable, and more reliable space transportation systems. These national policies are articulated in *The President's Goals for a National Partnership in Aeronautics and Research Technology*, the *National Space Policy* (a Presidential Directive) and *The National Space Transportation Policy*.

Strategic Goals and Objectives

The Enterprise has the following five strategic goals:

- Global Aviation—Enable U.S. leadership in global civil aviation through safer, cleaner, quieter, and more affordable air travel.
- Revolutionary Technology Leaps—Revolutionize air travel and the way in which aircraft are designed, built, and operated.
- Space Transportation—Enable the full commercial potential of space and expansion of space research and exploration.
- Research and Development (R&D)—Enable, as appropriate, on a national basis, world-class aerospace R&D services, including facilities and expertise, and proactively transfer cutting-edge technologies in support of industry and U.S. Government R&D.

Each of the Enterprise goals has one or more specific objectives to further define and shape the technology needs and accompanying investments. The outcome-focused nature of the objectives project a preferred end state within air and space transportation systems. As technologies mature, the private sector and Government can determine whether to make investments that take advantage of the new technologies. A sustained, multiyear investment in research, technology development, and both ground and flight verification tests is needed to mature the technologies. Performance targets established annually to measure progress toward each objective inherently cover a wide spectrum of impact, ranging from early investigative research to final technology verification activities.

Performance Measures

In FY 2000, there were 16 performance targets to measure progress toward the 10 specific objectives. The Enterprise met or exceeded 8 of the 16 targets during the fiscal year. Three targets were not fully accomplished, but are projected to be met during FY 2001, and the remaining five targets not achieved involve recovery plans with projected completion beyond FY 2001. The following material provides a detailed discussion of FY 2000 performance against each of the annual targets.

Global Civil Aviation

Goal: Enable U.S. leadership in global civil aviation through safer, cleaner, quieter, and more affordable air travel.

Objective: Contribute to aviation safety—reduce aircraft accident rate.

Performance Target: Flight-demonstrate a conceptual aircraft flight deck integrated with evolving ground-based runway incursion avoidance technologies installed at a major airport. **FY 2000 Aerospace Technology #3 (0R3)**

Reducing the possibility of runway incursion will reduce accidents, making air travel safer.

Actual Performance: Airborne and ground-based systems were checked out and data collection was completed on October 22, 2000 at Dallas/Fort Worth Airport. Demonstrations for individuals in the aviation community were held October 24–26, 2000.

Target Assessment: Yellow; did not achieve performance target (during FY 2000); progress was significant and achievement was completed during the first month of FY 2001.

Data Source: Aerospace Technology Program Management Accomplishment System (an electronic database for documenting and tracking program milestones and accomplishments).

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council, on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Objective: Contribute to environmental capability—reduce emissions.

Performance Target: Demonstrate, in a laboratory combustion experiment, an advanced turbine-engine combustor concept that will achieve up to a 70 percent reduction of oxides of nitrogen (NO_x) emissions based on the 1996 International Civil Aviation Organization (ICAO) standard. **FY 2000 Aerospace Technology #1 (0R1)**

Reducing engine emissions will help U.S. aircraft manufacturers meet national and international emissions standards.

Runway incursion avoidance technology.

Advanced low NO_x combustor technology.

Actual Performance: Three fuel injector concepts were tested in 25 atmosphere flame tubes. NO_x reductions of 83 percent, 76 percent, and 73 percent relative to the ICAO standard were achieved with three multipoint lean direct injectors: the 36 Point Integrated Module, the 25 Point Integrated Module, and the 9 Point Butterfly fuel injectors, respectively.

Target Assessment: Blue; significantly exceeded performance target.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Objective: Contribute to environmental compatibility—reduce noise.

Performance Target: Validate the technologies to reduce noise for large commercial transports by at least 7 decibels (dB) relative to 1992 production technology. **FY 2000 Aerospace Technology #2 (0R2)**

The reduction of aircraft noise will eliminate noise pollution currently associated with airport operations, making them environmentally acceptable to the community.

Actual Performance: System analysis indicates noise reduction of 7 dB, with the potential of up to 9 dB, from implementing the following technologies:

- Engine cycle changes alone were shown to reduce community noise impact 3 to 7 dB depending on aircraft suitability.
- Engine fan and stator geometry were optimized utilizing new noise prediction tools to reduce fan noise by 3 dB.
- Advanced low noise engine nozzles were developed that reduced jet noise of modern turbofan engines 3 dB.
- Engine inlet shape was investigated, and new designs reduced inlet fan noise 2 to 3 dB.
- New engine nacelle liner technology has shown the potential to reduce radiated fan noise (both forward and aft) 2 dB.
- Active noise control technologies were aggressively pursued and show the potential to enable new engine designs. There is the potential to reduce engine system noise in the airport community by more than 1 dB.
- Airframe noise, a dominant noise source on approach, was reduced 4 dB by improving the design of the flap, slat, and landing gear systems.
- Finally, changing airport vicinity operational designs were investigated and found to offer the potential to reduce community noise impact 2 dB.

Target Assessment: Green; achieved performance target.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise

Swept and leaned strators—technology for noise reduction.

review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Objective: Affordable air travel—increase throughput.

Performance Target: Conclude the Terminal Area Productivity project by field demonstrations of the complete suite of technologies and procedures that enable a 12 percent increase over 1994 nonvisual operations for single-runway throughput. **FY 2000 Aerospace Technology #4 (0R4)**

Increasing airport capacity will help the Nation meet consumer demand, as well as reduce airport delays and any negative impact to the Nation's economy.

Actual Performance: Demonstrated an increase of 12 to 15 percent in the throughput of a single runway during nonvisual operations if the following technologies are used:

- Center-TRACON (Terminal Radar Approach Control) Automation System/Flight Management System with Active Final Approach Spacing Tool
- Advanced Vortex Spacing System

Demonstrated the ability to reduce aircraft lateral spacing to 2,500 feet for independent operations on parallel runways by use of Airborne Information for Lateral Spacing.

Field demo of aircraft vortex sensing system.

Target Assessment: Green; achieved performance target.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Revolutionary Technology Leaps

Goal: Revolutionize air travel and the way in which aircraft are designed, built, and operated.

Objective: General aviation revitalization.

Performance Target: Perform flight demonstrations of advanced general aviation piston and turbine engines at the annual Oshkosh air show. **FY 2000 Aerospace Technology #7 (0R7)**

Developing new aircraft engines will revitalize the U.S. domestic general aviation industry by making general avia-

General Aviation Propulsion (GAP) piston engine aircraft installation.

tion aircraft more affordable.

Actual Performance: NASA's cooperative efforts with industry to develop advanced engine technology to revitalize general aviation continued in FY 2000.

Based on significant technical progress, Eclipse, a new aircraft company, announced that it will utilize a derivative of the turbine engine developed in this project, for the Eclipse 500 aircraft. NASA's partner, Williams International, requested cancellation of the flight demonstration, and the Agency agreed. The commitment by Eclipse to utilize a derivative of the turbine engine meets the intent of the performance target flight demonstration.

Slowed by technical problems, the piston engine was not ready for the flight demonstration. The engine was run in both the dynamometer and propeller test stands. A unique counterweight system developed for this engine is working well. The engine is running perfectly smoothly. The dynamometer test demonstrated development of full power while the propeller test demonstrated propeller/engine interaction and engine durability. The piston engine flight demonstration is scheduled for April 2001.

Target Assessment: Yellow; did not achieve performance target. Progress was significant, and achievement is anticipated within the next fiscal year.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Objective: Next generation experimental aircraft.

Performance Target: Demonstrate improved remotely piloted aircraft (RPA) science mission capability by increasing operational deployment time from three weeks to nine weeks with minimum airfield provisions and unrestricted airspace. **FY 2000 Aerospace Technology #11 (0R11)**

Next generation experimental aircraft will reduce operation costs associated with current high altitude research.

Actual Performance: The Experimental Research Aircraft and Sensor Technology (ERAST) project was replanned to be more responsive to the needs of the Earth Science community. The attempt to achieve the original target was deemed a less effective and efficient use of program resources. The original performance target was replaced by a demonstration of continuous over-the-horizon command and control capabilities of an RPA that would extend the operating range from 40 to 200 nautical miles. This operating range expansion is important to support Earth Science requirements.

The Proteus aircraft flew a series of direct commands from the ground station as well as a series of waypoint sets. The flexibility of the system was demonstrated when air traffic control directed the Proteus to change from its planned altitude of 45,000 feet to 44,000 feet. The ground controller quickly uploaded a descent command to bring the aircraft to the new altitude, and within two minutes the altitude for the entire route was updated and loaded on the aircraft.

Target Assessment: Red; did not achieve original performance target. (Green on the substitute target set for the program. The program's value is measured against the internally

Proteus in flight.

designed target, which was the most effective and efficient use of program resources.)

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Objective: Next Generation Experimental Aircraft.

Performance Target: Demonstrate in flight an airframe-integrated, dual-mode, scramjet-powered vehicle. **FY 2000 Aerospace Technology #6 (0R6)**

The test flight of the X-43 will prove air-breathing hypersonic engine technologies and hypersonic design tools.

Actual Performance: The first X-43 was delivered to Dryden Flight Research Center (DFRC) in October 1999. The first booster rocket, to which the X-43 will be attached at the nose, was accepted at DFRC in January 2000. Several technical challenges had to be overcome before completing validation testing and final preparations for flight.

Booster test mate to B-52 aircraft.

Technical risk was significantly reduced through 40 wind tunnel tests of the scramjet engine at simulated flight conditions of Mach 7 and 95,000 feet, which verified engine performance and operability, validated the flight engine control system, and provided powered and unpowered aerodynamic data.

Target Assessment: Yellow; did not achieve performance target. Progress was significant, and achievement is anticipated within the next fiscal year.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

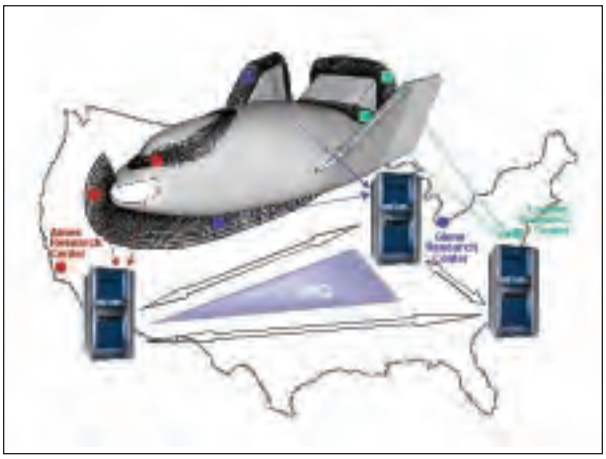
Objective: Next generation design tools.

Performance Target: Demonstrate a prototype heterogeneous distributed computing environment. **FY 2000 Aerospace Technology #8 (0R8)**

Advancing the state of the art in design tools will enable the development of new revolutionary aerospace concepts. Cost-effective design tools are facilitated if the computing environment does not require acquisition and use of identical computers (i.e., a homogenous computing environment). A heterogeneous environment uses available resources, and the computers do not have to be identical.

Actual Performance: The use of a heterogeneous distributed environment (termed the Information Power Grid [IPG]) prototype was demonstrated on two applications.

IPG services were used to explore the parameters of a framework of different computers to provide uniform access to these diverse resources to enable study of an aerospace vehicle design.



Information Power Grid supports aerodynamic analysis of X-38 Crew Return Vehicle.

A design application (referred to as a "molecular design") used IPG service to provide access to idle workstations to supply 0.5 million central processing unit hours for studying nanotechnology devices and materials.

Target Assessment: Green; achieved performance target.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Space Transportation

Goal: Enable the full commercial potential of space and expansion of space research and exploration.

Objective: Revolutionize space launch capabilities.

Artist concept of X-33 liftoff.

Performance Target: Conduct the flight testing of the X-33 vehicle. **FY 2000 Aerospace Technology #9 (0R9)**

A single-stage-to-orbit vehicle holds the promise of achieving the greatest level of cost-effectiveness in reusable launch vehicles. However, the mass of the vehicle, excluding the propellants, has to be greatly reduced. Non-conventional structural materials and concepts are required. The X-33 was being built to prove these advanced approaches. If successful, Lockheed Martin intended to build the full-scale vehicle, referred to as *VentureStar*. The Government entered into a "Cooperative Agreement" with a team of contractors led by Lockheed Martin. This approach allowed the Government to invest an established amount of resources, and required Lockheed Martin and its collaborators to invest the remainder.

Actual Performance: The technical development of the X-33 experienced a significant schedule and cost setback when the first of two liquid hydrogen (LH_2) lightweight tanks, using composite materials rather than aluminum-lithium materials, experienced a delamination of the composite materials immediately following a pressure and structural load test. The test was conducted at facilities sited at the MSFC in late November 1999. A joint NASA-Lockheed Martin team conducted a complete failure investigation. The findings of this team led to the conclusion that using composite materials as the primary structure for large cryogenic tanks required further technological development.

It was determined that a near-term flight of the X-33 would require replacing the composite hydrogen fuel tanks on the flight vehicle with metallic tanks. A Preliminary Design Review (PDR) of the aluminum LH_2 tank was completed in June 2000, and a Critical Design Review (CDR) was completed in August 2000. Lockheed Martin was not prepared to fund the additional costs required to carry forward with testing of the new metallic tanks and their integration into the X-33.

The Government determined that if additional Government funds were to be provided, the X-33 would need to be selected in a competitive proposal process as part of the Second Generation Reusable Launch Vehicle technology development program. The selection process did not result in the X-33 being chosen as a test bed for advanced technologies. As a result, the program's cooperative agreement expired on March 31, 2001, without final vehicle assembly.

Target Assessment: Red; failed to achieve performance target.

Data Source: Aerospace technology program management accomplishment system.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Objective: Revolutionize space launch capabilities.

Performance Target: Complete vehicle assembly and begin the flight test of the second X-34 vehicle. **FY 2000 Aerospace Technology #12 (0R12)**

Launch vehicles fly many times faster than the speed of sound. The hypersonic flight regime places unique stresses on vehicles. A Reusable Launch Vehicle that is more reliable, safer, and more cost-effective than the Space Shuttle will require a number of advances in the state of the art. This includes use of advanced materials, operational control approaches, and reduced staffing for ground operation crews. The X-34 was designed to function as a test vehicle to explore several technologies, including how to maintain a vehicle with few ground operations personnel.

X-34 Reusable Launch Vehicle.

Actual Performance: Early in the year, as a result of concerns over potential safety hazards due to the lack of redundancy in vehicle control systems, it was determined that the X-34 program should be restructured. A replanning activity was undertaken to address these concerns. It resulted in a determination that a significant amount of additional funding would be required on the part of the Government to meet the revised flight plans. Since making these additional funds available would require the reallocation of resources planned for the Space Launch Initiative (SLI), NASA decided that additional funding for X-34 risk reduction should be competed within the SLI evaluation process.

The X-34 was not competitively selected. As a result, NASA is terminating its contract with the Orbital Sciences Corporation, and the program will be canceled.

Target Assessment: Red; failed to achieve performance target.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible

for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Objective: Revolutionize space launch capabilities.

Performance Target: Complete small payload focused technologies and select concepts for flight demonstration of a reusable first stage (Bantam). **FY 2000 Aerospace Technology #17 (0R17)**

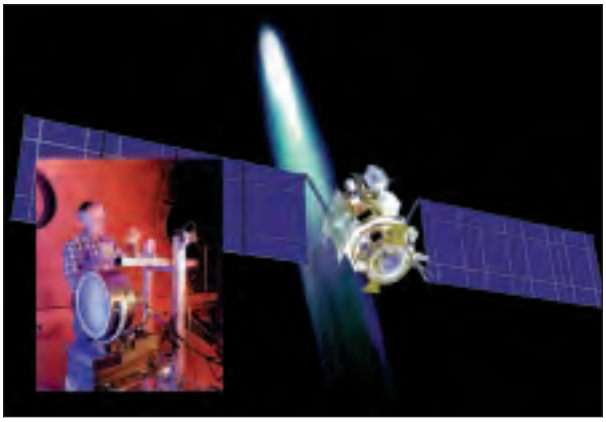
Reducing the cost of launching small payloads into orbit is critical to expanding the utilization of small, inexpensive spacecraft. Achieving this objective requires the development of suitable launchers. Because propulsion systems are technically demanding and often the cause of launch failures, a highly reliable, inexpensive propulsion system represents a difficult development. The Bantam launch vehicle was intended to demonstrate a reusable launcher that met the test of very low cost. NASA worked with launch suppliers to determine if the cost objectives could be met.

Actual Performance: After consulting with the launch suppliers during early 1999, it became clear that the cost objectives could not be met. With the agreement of the Administration, NASA notified the Congress of the outcome of the conference with launch suppliers and the decision to terminate the Bantam activity. Bantam funds were redirected to initiate the third-generation reusable launch vehicle technology activity (known as *Spaceliner 100*). This occurred in October 1999.

Target Assessment: Red; Activity was cancelled internally at the beginning of the fiscal year.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic



NASA Solar Propulsion Technology Applications Readiness (NSTAR).

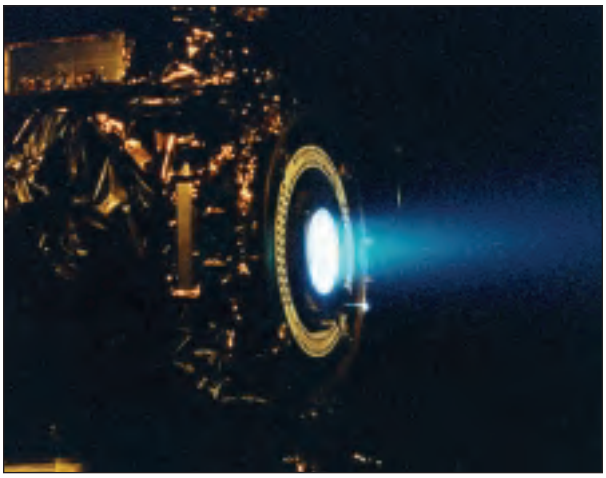
Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Objective: Revolutionize in-space transportation.

Performance Target: Complete NASA Solar Propulsion Technology Applications Readiness (NSTAR) Mission Profile (100 percent design life) ground testing for Deep Space-1 (concurrent, identical firing of an NSTAR engine in a vacuum chamber with the actual firing sequence of the in-flight propulsion system). **FY 2000 Aerospace Technology #10 (0R10)**

In addition to launching a spacecraft into orbit, there is a need to develop new space propulsion systems that work in the space environment to take the spacecraft to its ultimate destination. Current, chemical-based "in-space" propulsion systems are heavy, and thus require the initial launch vehicle to be larger, more capable, and considerably more expensive. Also, there is a great need to reduce the time to get the spacecraft to its destination because the transit time to planetary destinations is extremely long. New space propulsion systems can reduce spacecraft weight and speed mission travel time, thus reducing mission costs.

Actual Performance: Design life, for ion engines, is described by a measure of propellant mass discharged in multiple firings. In the case of the system employed on the



NSTAR engine ground test.

Deep Space-1 (DS-1) mission, 100 percent design life equated to consumption of 87 kilograms of xenon propellant. This level of propellant consumption was successfully achieved on May 9, 2000, during ground-based testing of the flight-spare engine in a 3-meter-diameter by 10-meter-long vacuum chamber at the Jet Propulsion Laboratory. Test procedures and performance results from this long duration evaluation have been documented in several peer-reviewed technical journals.

Prior to the NSTAR project and over a time span of more than 30 years, no ion engine to be used for primary propulsion had ever been successfully operated for more than a small fraction of its design life. The success of these tests, together with the success of the flight test on DS-1, has now made ion propulsion a legitimate option for deep space solar system exploration missions. The end result will be missions to scientifically interesting places with shorter trip times and the use of smaller, less expensive launch vehicles.

Target Assessment: Green; achieved performance target.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Research and Development

Goal: Enable, as appropriate, on a national basis, world-class aerospace R&D services, including facilities and expertise, and proactively transfer cutting-edge technologies in support of industry and U.S. Government R&D.

Objective: Provide world-class aerospace research and development services, facilities, and expertise.

Performance Target: Complete 90 percent of all Enterprise-controlled program milestones within three months of schedule. **FY 2000 Aerospace Technology #13 (0R13)**

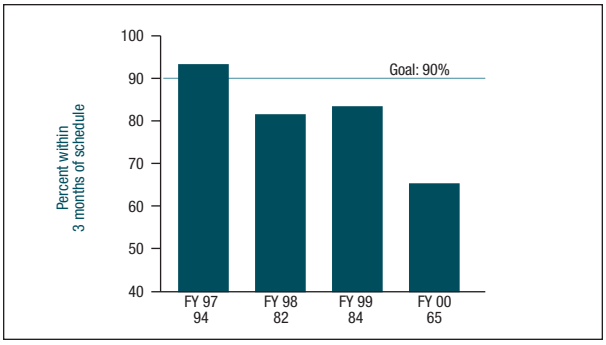
NASA provides technical capabilities, including unique facilities and expert personnel, to meet governmental needs. Each Aerospace Technology Enterprise program uses measurable, customer-negotiated product and service deliverables to track annual performance against plans, including specific success criteria for milestone completion assessment.

Actual Performance: This metric aggregates performance of all individual program milestones to provide a composite indicator of progress toward the 10 objectives of the Enterprise's 3 technology goals. Due to the changes in program performance plans, as noted in this section, the completion of planned milestones dropped to 65 percent.

Target Assessment: Red; did not achieve performance target.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise



Aggregate deliverables completed as percentage of planned deliverables.

review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

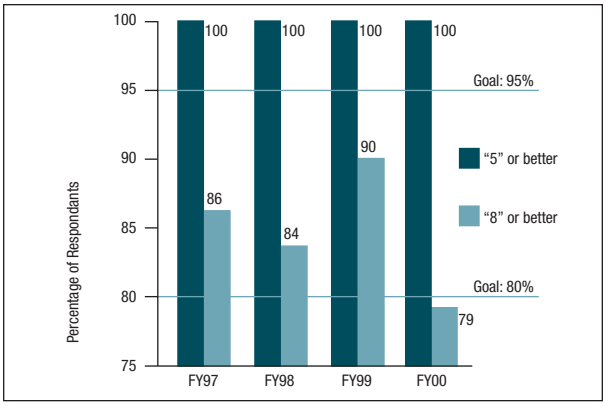
Performance Target: Achieve a facility utilization customer satisfaction rating of 95 percent of respondents at "5" or better and 80 percent at "8" or better, based on exit interviews. **FY 2000 Aerospace Technology #14 (0R14)**

The Enterprise provides its customers with world-class research facilities making possible revolutionary advancements in technology that will sustain U.S. leadership in civil aeronautics and space. A good way to measure how these facilities met the needs of the customers using them is through a satisfaction survey rating approach.

Actual Performance: One of the major services provided to its customers by the Enterprise is access to NASA's critical research and development facilities, such as wind tunnels. Three of the NASA Research Centers (Ames, Langley, and Glenn) conduct exit interviews at selected facilities. This metric aggregates the interview results to provide an overall indicator of customer satisfaction relative to the Enterprise research and development services goal. Facility-by-facility data are available and used to improve customer satisfaction. For FY 2000, the Enterprise essentially met the "8" or above goal, scoring 79 percent and exceeded the "5" or above goal, scoring 100 percent.

Target Assessment: Green

Data Source: Facility customer satisfaction surveys.



Facility utilization satisfaction.

Verification/Validation: Facility group directors review individual facility surveys with summary-level reports forwarded to NASA Headquarters semi-annually.

Performance Target: Transfer at least 12 new technologies and processes to industry during the fiscal year. **FY 2000 Aerospace Technology #15 (0R15)**

A key measure of the value of technology developments is their acceptance by U.S. industry. This is known as "technology transfer."

Actual Performance: At least 16 new technologies and processes were transferred to industry and other Government agencies during FY 2000:

Dryden Flight Research Center:
- Ring buffered network bus

Langley Research Center:
- Macro-Fiber composite actuator

Ames Research Center:
- Extended terminal area
- Decision support tools
- NGI multicast
- Low-noise rotor technology
- Large rotor test apparatus
- Active-control technology for rotorcraft interior-noise reduction
- Pretrained (Levenberg-Marquardt) neural net
- Dynamic cell structure neural net

Intelligent flight controls and mini automated flight control system
Portable batch system
Digital engine operating system formal methods
Advance design technology test bed (ADTT) tools technology

Glenn Research Center:

Aircraft icing training video for regional and corporate pilots
Numerical propulsion system Simulation V1
Gamma titanium aluminide

Target Assessment: Blue; significantly exceeded performance target.

Data Source: Aerospace Technology Program Management Accomplishment System.

Verification/Validation: The data used to substantiate actual performance originated at the NASA Centers responsible for program implementation. The data were verified by senior officials at those Centers and also during the periodic Enterprise review process at NASA Headquarters, including the NASA Program Management Council on selected programs and projects. The above assessment was also reviewed by the Aerospace Technology Committee of the NASA Advisory Council.

Performance Target: Continue the implementation of current education outreach plans and establish new plans for all new program activities initiated in FY 2000. **FY 2000 Aerospace Technology #16 (0R16)**

Involving educators and students in the Enterprise's R&D efforts is a proactive attempt to encourage the development of new technologies.

Actual Performance: Successfully completed development and implementation of education outreach program plans for all three new programs/projects in FY 2000, and exceeded milestone with the development and implementation of an education plan for the existing Aerospace Propulsion and Power program. These plans have been designed in collaboration with the Center Education Offices to address the goals and objectives of the overall NASA Education Program while involving educators and students in the unique research and development activities of NASA's Aerospace Technology Enterprise. The following program activities have established Education Outreach Plans:

- Future-X/Pathfinder Program—Marshall Space Flight Center (FY 1999 target completed during FY 2000)
- Ultra-Efficient Engine Technology Program—Glenn Research Center
- Revolutionary Concepts Project—Dryden Flight Research Center
- Aviation Safety Program—Langley Research Center
- Aerospace Propulsion and Power Program—Glenn Research Center

Target Assessment: Blue; significantly exceeded performance target.

Data Source: Aerospace Technology Program educational outreach plans.

Verification/Validation: The Program Offices have verified that they have developed education outreach program plans by providing copies of the plans to the Office of Aerospace Technology. The value of each plan to the overall NASA Education Program has been validated by the Center Education Officers.

FY 2000 AEROSPACE TECHNOLOGY TREND DATA

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Aviation safety.	9R5	For the aviation safety areas of controlled flight into terrain, runway incursion, and loss of control, identify the contributing causes to be addressed, potential solutions using current capabilities, and gaps that require technology solutions.	Green	0R3	Flight demonstrate a conceptual aircraft flight deck integrated with evolving ground-based runway incursion avoidance technologies installed at a major airport.	Yellow	Significant progress continues to be made in developing technologies to address the key contributors to aviation accidents.
	9R2	Characterize the Super-cooled Large Droplets (SLD) icing environment, determine its effects on aircraft performance, and acquire and publish data to improve SLD forecasting confidence.	Yellow		[Not applicable.]		Target eliminated.
Environmental compatibility (aviation emissions).	9R1	Demonstrate an advanced turbine-engine combustor that will achieve up to a 50% reduction of oxides of nitrogen emissions based on 1996 ICAO standards.	Green	0R1	Demonstrate, in a laboratory combustion experiment, an advanced turbine-engine combustor concept that will achieve up to a 70% reduction of oxides of nitrogen emissions based on the 1996 ICAO standard.	Blue	In FY 1999, an advanced combustor that reduced NO_x emissions by 50% was demonstrated in a full-scale engine. Continued progress in FY 2000 as the first step was completed in developing technology toward the Enterprise goal of 70% reduction in NO_x emissions by the laboratory demonstration of three new fuel injector concepts.
Environmental compatibility (aviation noise).				0R2	Validate the technologies to reduce noise for large commercial transports by at least 7 decibels relative to 1992 production technology.	Green	FY 2000 achievements represent strong initial steps toward the 2007 strategic objective to reduce aircraft noise.
Aviation system throughput.				0R4	Conclude the Terminal Area Productivity project by field demonstrations of the complete suite of technologies and procedures that enable a 12% increase over 1994 nonvisual operations for single-runway throughput.	Green	Activity successfully completed on schedule with strong participation by both the Federal Aviation Administration and industry to enhance technology transfer.

AEROSPACE TECHNOLOGY TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
High-speed travel.	9R6	Produce a complete vehicle system configuration document that includes impact of technology validation efforts from 1990 through 1999. This document will support the evaluation of technology selection decisions for a future High Speed Civil Transport.	Green		[Not applicable.]		Research in high speed travel was terminated with the High Speed Research program at the end of FY 1999.
General aviation revitalization.	9R8	Conclude preflight ground testing of the general aviation piston and turbofan engines.	Yellow	0R7	Perform flight demonstrations of advanced general aviation piston and turbine engines at the annual Oshkosh air show.	Yellow	The turbine engine technology is a significant contributor to the revitalization of general aviation. This technology was successfully transferred to industry in FY 2000. The piston engine development was slowed by technical problems. It is projected that the piston engine development will be concluded in FY 2001.
"Next-generation design tools."	9R12	Demonstrate up to a 200-fold improvement over the 1992 baseline (reduction from 3,200 hours to 15) in the time-to-solution for a full combustor simulation on NASA's National Propulsion System Simulation advanced applications on computational testbeds that can be increased to sustained TeraFLOPS capability.	Blue	0R8	Demonstrate a prototype heterogeneous distributed computing environment.	Green	Improvements in computational capability demonstrated in FY 1999 continued in FY 2000 with successful transition to a heterogeneous computing environment.
	9R13	Demonstrate communication testbeds with up to 500-fold improvement over the 1996 baseline (increase from 300 kilobits per second to 150 megabits per second) in end-to-end performance.	Blue		[Not applicable.]		Target eliminated.

AEROSPACE TECHNOLOGY TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Next-generation experimental aircraft.	9R11	Complete low-altitude flights of an RPA with a wingspan greater than 200 feet, suitable for flight to 100,000 feet in altitude once outfitted with high-performance solar cells.	Green	0R11	"Demonstrate improved RPA science mission capability by increasing operational deployment time from 3 weeks to 9 with minimum airfield provisions and unrestricted airspace. Target reported against: Demonstrate continuous over-the-horizon command and control capabilities of an RPA that would extend the operating range from 40 to 200 nautical miles.	Red	ERAST was replanned to be more responsive to the needs of the Earth Science community. Significant progress has continued in developing RPA technology that will provide long-duration air platforms that will enable significant advances in data collection and the understanding of Earth and its environment.
	9R11	Conduct RPA flight demonstration to validate the capability for science missions of greater than 4 hours duration in remote deployments to areas such as the polar regions above 55,000 feet.	Green				Target eliminated.
				0R6	Demonstrate in flight an airframe-integrated, dual-mode, scramjet-powered vehicle.	Yellow	While progress continues on the development of the trailblazing Hyper-X (X-43) vehicle, it has been slowed in order to incorporate additional risk mitigation activities that will increase the probability of mission success.
Revolutionize space launch capabilities.	9R14	Continue the X-33 Vehicle Assembly in Preparation for Flight Testing.	Green	0R9	Conduct the flight testing of the X-33 vehicle.	Red	Substantial progress was made in the X-33 technology developments, particularly in the aerospike engine. However, the failure of the composite hydrogen tank during ground testing led to a decision to baseline an aluminum-lithium hydrogen tank. Because additional funding was required to complete the X-33 beyond the Government's stated commitment, and our

AEROSPACE TECHNOLOGY TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Revolutionize space launch capabilities (continued).							industry partner, Lockheed Martin, was unwilling to provide the necessary funding, NASA elected to make a decision on additional Government funding contingent on a competitive selection process under the Space Launch Initiative. The X-33 was not selected.
	9R15	Complete Vehicle Assembly and Begin Flight Testing of the X-34.	Yellow	0R12	Complete vehicle assembly and begin the flight test of the second X-34 vehicle.	Red	Due to the unforeseen additional costs required to conduct flight tests safely and effectively, NASA elected to make a decision on additional Government funding contingent on a competitive selection process under the Space Launch Initiative. The X-34 was not selected.
				0R17	Complete small payload focused technologies and select concepts for flight demonstration of a reusable first stage (Bantam).	Red	Congress was notified of NASA's decision to terminate Bantam activity.
Revolutionize in-space transportation.				0R10	Complete NSTAR Mission Profile (100% design life) ground testing for Deep Space-1 (concurrent, identical firing of an NSTAR engine in a vacuum chamber with the actual firing sequence of the in-flight propulsion system).	Green	New target.
Provide world-class aerospace research and development services, facilities, and expertise.	9R16	Complete 90% of all Enterprise-controlled milestones within 3 months of schedule.	Yellow	0R13	Complete 90% of all Enterprise-controlled milestones within 3 months of schedule.	Red	The percentage of controlled milestones that were completed within 3 months of the planned date fell to 65% in FY 2000. The FY 2000 performance was hampered by schedule slips resulting from both technical problems, as well as additional efforts directed at increasing the probability of mission success on flight-related activities.

AEROSPACE TECHNOLOGY TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Provide world-class aerospace research and development services, facilities, and expertise (continued).	9R17	Achieve a facility utilization customer satisfaction rating of 95% of respondents at "5" or better and 80% at "8" or better based on exit interviews.	Blue	0R14	Achieve a facility utilization customer satisfaction rating of 95% of respondents at "5" or better and 80% at "8" or better, based on exit interviews.	Green	Significant progress has continued in achieving a facility utilization customer satisfaction rating of 100% of respondents at "5" or better, but only a 79% at "8" or better, based on exit interviews.
	9R19	Transfer at least 10 new technologies and processes to industry during the fiscal year.	Blue	0R15	Transfer at least 12 new technologies and processes to industry during the fiscal year.	Blue	The number of technology transfers increased from 12 in FY 1999 to 16 in FY 2000.
	9R21	For all new program activities initiated in FY 1999, develop an education outreach plan, which includes and results in an educational product. This product shall be consistent with current educational standards and use program content to demonstrate or enhance the learning objectives.	Yellow	0R16	Continue the implementation of current education outreach plans and establish new plans for all new program activities initiated in FY 2000.	Blue	The Aerospace Technology Enterprise continues to demonstrate its commitment to supporting the improvement of education in the United States. All new FY 2000 programs have active education outreach plans; in addition, one existing program also created an educational outreach plan.
	9R20	Establish an Aeronautics Education Laboratory in at least three new sites in the United States.	Blue		[Not applicable.]		Target eliminated.
	9R18	Complete the Triennial Customer Satisfaction Survey, and achieve an improvement from 30 percent to 35 percent in "highly satisfied" ratings from Enterprise customers.	Green		[Not applicable.]		Target not applicable in FY 2000 (next triennial survey is in FY 2001).

Manage Strategically

Manage Strategically

Through NASA, the American people have invested in an irreplaceable public aerospace research and development infrastructure, consisting of a unique combination of physical resources and human talents. Managing these resources effectively and strategically is critical to achieving NASA's goals and objectives. By integrating good general management practices with NASA's strategic processes, the Agency ensures that decisions are consistent with the goals, objectives, and strategies contained in NASA's Strategic, Implementation, and Performance Plans. Managing strategically encourages all parts of the Agency to proceed together toward achieving a single set of strategic goals while enhancing management's ability to leverage limited resources, standardize processes where it makes sense to do so, streamline processes for timely results, and ensure rapid, reliable, open exchanges of information. In FY 2000, NASA's strategic management performance objectives and associated performance targets required the Agency to make the most effective use of appropriated funds, workforce, facilities, procurement processes, and information technologies.

Goal: Provide a basis for the Agency to carry out its responsibilities effectively and safely and enable management to make critical decisions regarding implementation activities and resource allocations that are consistent with the goals, objectives, and strategies contained in NASA's Strategic, Implementation, and Performance Plans.

Objective: Optimize investment strategies and systems to align human, physical, and financial resources with customer requirements, while ensuring compliance with applicable statutes and regulations.

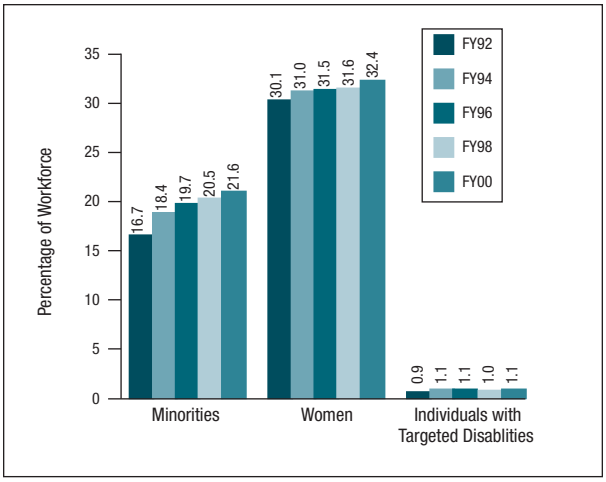
Performance Target: Reduce the civil service workforce level to below 18,200. **FY 2000 Manage Strategically #1 (0MS1)**

Actual Performance: Actual full-time equivalent (FTE) usage for FY 2000 was 18,375 (including the Inspector General [IG]). In December 1999, NASA declared an end to downsizing, based on key indicators and recommendations from the NASA Advisory Council, that the Agency had gone too far in downsizing, particularly at the Office of Space Flight. In January 2000, the Agency began focusing on workforce renewal and revitalization. The NASA FTE budget Ceiling was changed in the FY 2001 Congressional Budget for FY 2000 to 18,954 (including IG).

Target Assessment: No longer applicable

Data Source: NASA Personnel Payroll System (NPPS).

Verification/Validation: The target owner does not provide any independent verification and validation of FTE data



Workforce diversity.

taken from NPPS. NPPS is itself an Agency system, subject to random audit. NPPS is audited as part of the independent audit of the Agency's Annual Accountability Report. The independent audit firm is responsible for performing agreed-upon procedures related to NASA's payroll system. The results of the audit then are reported to the Office of Personnel Management's Office of Inspector General.

Performance Target: Maintain a diverse NASA workforce throughout the downsizing efforts. **FY 2000 Manage Strategically #2 (0MS2)**

Actual Performance: NASA more than maintained diversity throughout the downsizing, steadily increasing minority and female representation. Minority representation increased from 16.7 percent of the NASA workforce at the end of FY 1992 to 21.6 percent of the NASA workforce at the end of FY 2000. Female representation increased from 30.1 percent of the NASA workforce at the end of FY 1992 to 32.4 percent at the end of FY 2000. Representation of individuals with targeted disabilities also increased above the FY 1992 level, from 0.9 percent to 1.1 percent of the NASA workforce. (The use of buyouts increased workforce diversity because a majority of those taking buyouts were white males.) Future increases in diversity will require more focus on hiring women, minorities, and individuals with targeted disabilities.

Target Assessment: Green

Data Source: Consolidated Agency Personnel and Payroll System (CAPPS).

Verification/Validation: The Office of Human Resources and Education maintains the CAPPS database. The database is validated as the only automated source of Agencywide workforce data.

Performance Target: Reduce the number of Agency lost workdays (from occupational injury or illness) by five percent from the FY 1994–96 three-year average. **FY 2000 Manage Strategically #3 (0MS3)**

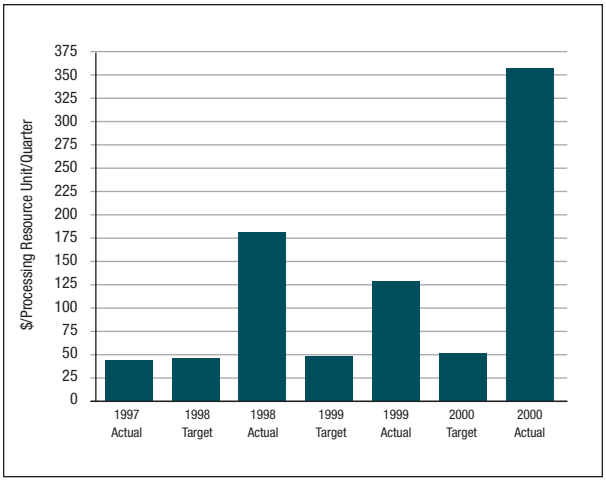
Actual Performance: NASA's goal is 0.30 lost-time work cases per 200,000 employee work hours. In the first year of NASA's increased emphasis on Agency workplace safety and health, NASA exceeded its target. Actual lost time due to injuries and illnesses per 200,000 hours worked was 0.22.

Target Assessment: Blue

Data Source: Incident Reporting Information System (IRIS), the Agencywide mishap data management system. Each organization of NASA is responsible for submitting mishap/occupational illness experiences into the reporting process. The data are collected and analyzed centrally.

Verification/Validation: The first-line supervisor of the injured employee enters the mishap/occupational illness data into the IRIS system. The organization's safety and health official oversees data entry into the electronic data collection process and validates the supervisor's input. This process is dictated by Agency policy and procedural guidelines (NPD 8621.1, NASA Mishap Report and Investigating Policy, and NPG 8621.1, NASA for Mishap Reporting, Investigating, and Recordkeeping). The reporting process is spot-checked during verification reviews that are conducted periodically at each Center to assure that the information is being processed properly.

Performance Target: Achieve a five-percent increase in physical resource costs avoided from the previous year through alternate investment strategies in environmental and facilities operations. **FY 2000 Manage Strategically #12 (0MS12)**



Office of Management Systems resource cost avoidance.

Actual Performance: The FY 2000 target for cost avoidance was $51.2M. In FY 2000, the actual cost avoidance associated with the Headquarters Office of Management Systems (OMS) functional areas (Facilities Engineering Division, Environmental Management Division, and the Logistics Management Office) was $366.29M attributable in the following major categories:

Facilities: $18.12M Total
Maintenance Initiatives = $18.12M

Environment: $28.37M Total
Energy Conservation = $26.953M
Recycling = $.0551M
Pollution Prevention Initiatives = $0.862M

Logistics: $319.8M Total
Acquisition of Idle and Excess Property = $1.398M
Exchange/Sale allowance proceeds returned to NASA to offset new procurement expenditures = $318.425.M

Target Assessment: Blue

Data Source: Center reports, the NASA Environmental Tracking System Database (which contains information on activities at Centers related to pollution, energy conservation, and recycling activities), and annual Personal Property Reports.

Verification/Validation: On a routine basis, each Center program activity manually collects data to support the determination of total cost avoidance. The manually collected data is entered into program-specific Agency databases and information management systems for periodic analysis by OMS. Center manual data collection activities are monitored by OMS officials via the use of data calls, staff visits, teleconferences, and periodic reviews to ensure compliance with program reporting guidelines, Agency policies, and regulatory mandates.

Performance Target: Cost 70 percent or more of available resources. **FY 2000 Manage Strategically #4 (0MS4)**

Actual Performance: NASA costed 80.9 percent of available resources in FY 2000.

Target Assessment: Green

Data Source: NASA's Financial and Contractual Status (FACS) report for the end of FY 2000.

Verification/Validation: FACS reports constitute the Agency's official documentation of its costs and obligations during the fiscal year. They are compiled monthly, based on input from the various NASA Centers, Headquarters, and the Jet Propulsion Laboratory.

Performance Target: Begin the implementation at NASA installations of the Integrated Financial Management System (IFMS) following the completion of system testing. **FY 2000 Manage Strategically #11 (0MS11)**

Actual Performance: NASA did not begin implementing the IFMS at NASA Centers. Extended system testing demonstrated that the software product was not ready for deployment and would not meet NASA's needs, so the Agency terminated the contract. NASA then reformulated the program, breaking implementation into individual software modules, and selected a new software product as the Core Financial System (CFS). NASA will begin the CFS Agency Design Phase in FY 2001, complete pilot Center activities in FY 2002, and implement the system at the remaining Centers in FY 2003.

Target Assessment: Red

Verification/Validation: IFMS is one of the functional initiatives under the authority of the Headquarters Program

Management Council (PMC). The program has a signed Program Commitment Agreement. A Non-Advocate Review was conducted during July 2000, and an Independent Annual Review was conducted in January 2001. The results of these reviews are reported formally to the PMC. Progress on the IFMS also is reported at periodic meetings of the Integrated Financial Management Council.

Objective: Improve the effectiveness and efficiency of Agency acquisitions through the use of techniques and management that enhance contractor innovations and performance.

Performance Target: Of funds available for Performance Based Contracts (PBC), maintain PBC obligations at 80 percent. (Funds available exclude grants, cooperative agreements, actions less than $100,000, the Small Business Innovative Research (SBIR) and Small Business Technology Transfer (SBTT) programs, Federally Funded Research and Development Centers (FFRDC), intragovernmental agreements, and contracts with foreign governments or international organizations.) **FY 2000 Manage Strategically #5 (0MS5)**

Actual Performance: NASA exceeded its FY 2000 PBC performance target by obligating 84 percent of available funds.

Target Assessment: Green

Data Source: FACS system. FACS contains acquisition data submitted by all NASA Centers.

Verification/Validation: NASA Headquarters periodically examines a sampling of contracts to determine whether they meet the definition of a "performance-based contract." In addition, through extensive interviews and sampling of PBC contracts at all nine NASA Centers, a Headquarters-led PBC Assessment Team reviewed over 117 contracts coded as PBC actions. The team looked for best practices, compliance with PBC policy, and the accuracy of the percentage of PBC effort reported under the FACS system. The team concluded their work in FY 2000. Several of the team's observations are being studied as possible ways to further strengthen NASA's application and tracking of PBC performance throughout the Agency.

Performance Target: Achieve at least the congressionally mandated eight-percent goal for annual funding to small disadvantaged businesses (including prime and subcontracts, small disadvantaged businesses, Historically Black Colleges and Universities, other minority institutions, and women-owned small businesses). **FY 2000 Manage Strategically #8 (0MS8)**

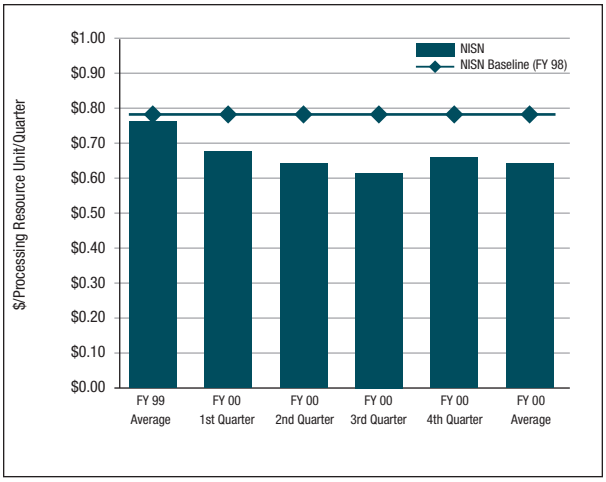
[NOTE: The performance target should have read, "including prime and subcontracts *to* small advantaged businesses, Historically Black Colleges and Universities, other minority institutions, and women-owned small businesses." Performance measured against this target does include prime and subcontracts to all categories of small disadvantaged businesses.]

Actual Performance: NASA exceeded the FY 2000 Agencywide goals in all categories negotiated with the Small Business Administration and exceeded the mandated eight-percent goal with an actual performance of 18.3 percent. The NASA/Prime Contractor Roundtable, which brings together NASA small business specialists and contractor small business liaison officers, was instrumental in achieving this success. Another contributing factor was the Minority Business Resource Advisory Committee, composed of small business owners, who advise the NASA Advisory Council and the NASA Administrator on how to increase the involvement of small businesses in the NASA industrial base.

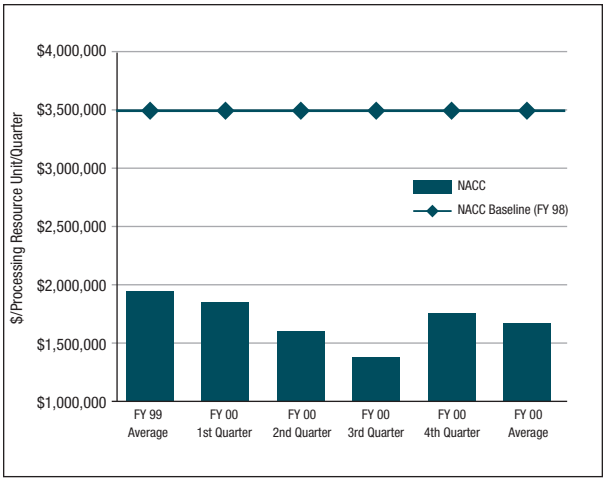
Target Assessment: Blue

Data Source: NASA Centers report activity using the Agencywide NASA Procurement Management System for direct contract awards. The large prime contractors furnish data on their small business awards using the Subcontracting Reporting for Individual Contracts (SF 294) and the Summary Subcontractor Report (SF 295). Agency reports are forwarded to the GSA Federal Procurement Data Center for consolidation into Governmentwide reports sent to the President and Congress.

Verification/Validation: Contracting officers and small business specialists at the Centers analyze and verify data on direct contract awards. Contract analysts in the Headquarters Office of Procurement review and verify data submitted by large businesses that are required to submit the Summary



NASA Integrated Services Network (NISN) unit cost metric.



NASA ADP Consolidation Center (NACC) unit cost metric.

Subcontract Report (SF 295). In addition, the Small Business Advisor in the Headquarters Office of Small and Disadvantaged Business Utilization consolidates the small business data to ensure its accuracy before publication. Headquarters oversight personnel also do data checks during periodic Procurement Management Surveys at the Centers, and the Small Business Administration and the Department of Defense Contract Management Agency conduct data reporting surveys at large business locations, as required.

Objective: Improve information technology capability and services.

Performance Target: Improve Information Technology (IT) infrastructure service delivery to provide increased capability and efficiency while maintaining a customer rating of "satisfactory" and holding costs per resource unit to the FY 1998 baseline. **FY 2000 Manage Strategically #10 (0MS10)**

Actual Performance: NASA met all Agency IT customer satisfaction and cost performance targets in FY 2000. NASA improved performance of Agencywide IT support while maintaining customer ratings of "satisfied" to "very satisfied." In addition, NASA held or reduced costs from all the baselines.

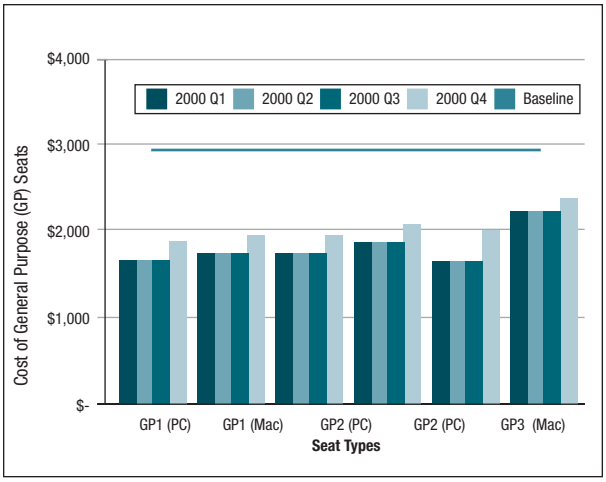
Following are the specific baselines for all three IT services:

In FY 1998, the NASA Integrated Services Network (NISN) performance metrics were baselined at customer satisfaction of "satisfactory" (score of 3.67 out of a possible score of 5); and unit cost of $.078 per thousand (kilo) bits per second (kbps) available. These baselines were unchanged in FY 2000.

In FY 1998, the NASA ADP Consolidation Center (NACC) performance metrics were baselined at customer satisfaction of "satisfactory" (score of 3.67 out of a possible score of 5); and unit cost of $5.2M per million instructions per second (MIPS) available. In FY 1999, the NACC processors were upgraded with new technology that made it possible for them to process the same or larger workloads with fewer MIPS available. However, MIPS became an unrealistic measure of unit cost. Therefore, in March 2000, NASA rebaselined the NACC unit cost metric using processing resource units with FY 1998 NACC costs and NACC processing units available in FY 1998. The NACC performance baselines became customer satisfaction of "satisfactory" (score of 3.67 out of a possible score of 5); and unit cost of $3.5M per processing resource unit.

The Outsourcing Desktop Initiative for NASA (ODIN) support was not available until FY 1999. During FY 1999, ODIN performance metrics were baselined at: customer satisfaction response of "satisfactory" at least 90 percent of the time, and unit cost of $2,940 for a standard workstation.

Actual ratings and per unit costs for each service are shown below compared to the baselines:



Outsourcing Desktop Initiative for NASA (ODIN) quarterly average cost per seat.

Target Assessment: Green

Data Source: Customer surveys and certification by managers and contractors.

Actual Customer Satisfaction for FY 2000	
NASA Integrated Services Network (NISN)	Satisfied
NASA ADP Consolidation Center (NACC)	Very Satisfied
Outsourcing Desktop Initiative for NASA (ODIN)	90.35% of customer responses were "Very Good" or better
Baseline Customer Satisfaction	
NACC and NISN	Satisfied
ODIN	90 percent of customer responses of "Very Good" or better
Unit Cost for FY 2000	
Actual Average NISN $/kbps/month	$ 0.65
Baseline Average NISN $/kbps/month	$ 0.78
Actual Quarterly Average NACC $/ Processing Resource Unit	$1,668
Baseline Quarterly NACC $/ Processing Resource Unit	$3,513
Actual Average ODIN $/GP Seat	$1,831
Baseline Average ODIN $/GP Seat	$2,940

Verification/Validation: The Chief Information Officers of NASA's Centers, the staff of the NACC, the NISN project office staff, and the ODIN project office staff verify information technology performance data. The verification process consists of review(s) by several layers of management and making metrics available to customers being served.

FY 2000 MANAGE STRATEGICALLY TREND DATA

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Optimize investment strategies and systems to align human, physical, and financial resources with customer requirements, while ensuring compliance with applicable statutes and regulations.	MS1	Reduce the civil service workforce to below 19,000.	Green	0MS1	Reduce the civil service workforce to below 18,200.	No Longer Applicable.	Performance progressed across the 2 years; however, in December 1999, NASA, with Office of Management and Budget approval, declared downsizing complete. This was done due to key indicators and recommendations from the NASA Advisory Council that the Agency had gone too far in downsizing. Since January 2000, the Agency has focused on workforce renewal and revitalization. The actual FTE usage for FY 2000 was 18,375.
	MS2	Maintain a diverse NASA workforce throughout the downsizing efforts.	Green	0MS2	Maintain a diverse NASA workforce throughout the downsizing efforts.	Green	The Agency has achieved its objective of maintaining diversity throughout the downsizing efforts. The representation of women, minorities, and individuals with targeted disabilities have all increased over FY 1992 levels. The use of buyouts enabled the Agency to increase workforce diversity, because the majority taking buyouts were white males.
	MS3	Reduce the number of Agency lost workdays (from occupational injury or illness) by 5% from the FY 1994-96 3-year average.	Green	0MS3	Reduce the number of Agency lost workdays (from occupational injury or illness) by 5% from the FY 1994-96 3-year average.	Blue	The trend for the past 2 years indicates that there was a significant reduction in lost workday experience due to injury or occupational illness within the Agency. The Agency Safety Initiative (ASI) was developed in late FY 1999 and fully implemented in FY 2000. The ASI was implemented to ensure that NASA's culture does not accept mishaps in the workplace and to encourage

MANAGE STRATEGICALLY TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Optimize investment strategies and systems to align human, physical, and financial resources with customer requirements, while ensuring compliance with aplicable statutes and regulations (continued).							both employees and managers to take responsibility for creating a safe workplace. These changes are being accomplished through training of the employees and supervisors and through performance assessment.
	MS4	Achieve a 5% increase in physical resource costs avoided from the previous year through alternative investment strategies in environmental and facilities operations.	Green	0MS12	Achieve a 5% increase in physical resource costs avoided from the previous year through alternate investment strategies in environmental and facilities operations.	Blue	Proactive, efficient, and effective management practices utilized by the various divisions within the Office of Management Systems have continued to produce significant cost savings for the Agency. In FY 1999, $48.7M in cost avoidance was planned, with actuals totaling $128.1M. The planned FY 2000 target was $51.2M. In FY 2000, $366.3M in cost savings were actually achieved in the following major categories: $18.2M in facilities; $28.4M in environmental management; and $319.8M in logistics, the majority of which come from the exchange/sale allowance proceeds returned to NASA to offset new procurement expenditures.
	MS5	Achieve 70% or more of the resources authority available to cost within the fiscal year.	Green	0MS4	Cost 70% or more of available resources.	Green	NASA continued to meet the target of costing 70% or more of its available resources, actually costing 80.9% of its resources available to cost in FY 2000. This target provides NASA with a measure of how effectively it utilizes its financial resources and ensures that the Agency does not allow a disproportionate percentage of these resources to be unutilized.

MANAGE STRATEGICALLY TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Optimize investment strategies and systems to align human, physical, and financial resources with customer requirements, while ensuring compliance with aplicable statutes and regulations (continued).	MS12	Complete system validation of the Integrated Financial Management Program and complete system implementation at Marshall and Dryden.	Red	0MS11	Begin the implementation at NASA installations of the Integrated Financial Management System following the completion of system testing.	Red	NASA determined that the software product being tested for the Integrated Financial Management System would not meet the Agency's needs and terminated the contract. The program has been reformulated, and NASA recently selected a new product for its Core Financial System. The design phase for the revised program will begin in FY 2000; pilot Center activities will be completed in FY 2002, and NASA will implement the system at its remaining Centers in FY 2003.
Improve effectiveness and efficiency of Agency acquisitions through the increased use of techniques and management that enhance contractor innovations and performance.	MS6	Increase obligated funds available for PBCs to 80% (funds available exclude grants, cooperative agreements, actions less than $100,000, SBIR, STTR, FFRDCs, intragovernmental agreements, and contracts with foreign governments or international organizations).	Green	0MS5	Of funds available for PBCs, maintain PBC obligations at 80% (funds available exclude grants, cooperative agreements, actions less than $100,000, SBIR, STTR, FFRDCs, intragovernmental agreements, and contracts with foreign governments or international organizations).	Green	NASA continued to meet its PBC obligation goals and obligated 84% of funds available against PBCs in FY 2000. The Office of Procurement continued to periodically examine samplings of contracts to determine whether they meet the definition of PBC. Additionally, a PBC assessment team reviewed over 100 contracts coded as PBC. The team looked for best practices, compliance with PBC policy, and the accuracy of the percentage of the PBC effort reported under the Financial and Contractual Status System.

MANAGE STRATEGICALLY TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Improve effectivness and efficiency of Agency acquisitions through the increased use of technologies and management that enhance contractor inovations and performance (continued).	MS7	Achieve at least the congressionally mandated 8% goal for annual funding to small disadvantaged businesses (including prime and subcontractors to small disadvantaged businesses, HBCUs, other minority educational institutions, and women-owned small businesses).	Green	OMS8	Achieve at least the congressionally mandated 8% goal for annual funding to small disadvantaged businesses (including prime and subcontractors, small disadvantaged businesses, HBCUs, other minority institutions, and women-owned small businesses).	Blue	Progress against this target has increased consistently since first measured in FY 1994. Over the past two fiscal years, the percentage has continued increasing from 16.1% in FY 1999 to a historic high of 18.3% in FY 2000. The NASA/Prime Contractor Roundtable, which brings together NASA small business specialists and contractor small business officers, contributed to achieving this level. The Minority Business Resources Advisory Committee, composed of external experts, provided useful advice on increasing the involvement of small businesses in the NASA industrial base.
	MS9	Enhance contract management through improved systems and information for monitoring, and through an emphasis on the training of procurement personnel, and revise metrics to assess the overall health of the procurement function.	Green				Target was completed in FY 1999. The Office of Procurement implemented a revised set of procurement metrics to assess the health of the procurement function.
	MS10	Enhance contract management through improved systems and information for monitoring by implementing a strategy for evaluating the efficacy of procurement operations.	Green				Target was completed in FY 1999. A revised strategy was implemented through a combination of Headquarters-led procurement surveys, periodic Center self-assessments, and periodic ISO audits.

MANAGE STRATEGICALLY TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Improve information technology capabilities and services.	MS8	Improve information technology infrastructure service delivery to provide increased capability and efficiency while maintaining a customer rating of "satisfactory" and holding costs per resource unit to the FY 1998 baseline.	Green	0MS10	Improve information technology infrastructure service delivery to provide increased capability and efficiency while maintaining a customer rating of "satisfactory" and holding costs per resource unit to the FY 1998 baseline.	Green	FY 1999 and FY 2000 performance remained consistently high. The NASA ADP Consolidation Center (NACC) cost metric was modified to more accurately measure the performance of enhanced technology. ODIN was added to the set of services being measured. Customer satisfaction with NACC and NISN services remains well above satisfactory. The cost of NACC, NISN, and ODIN services continues to remain well below the baseline cost.
	MS11	Complete remediation of mission-critical systems by March 1999, consistent with Government-wide guidance for 2000.	Green				Target was eliminated. Concerns regarding the turnover to the Year 2000 were successfully mitigated with no significant problems noted.

Provide Aerospace Products and Capabilities

Provide Aerospace Products and Capabilities

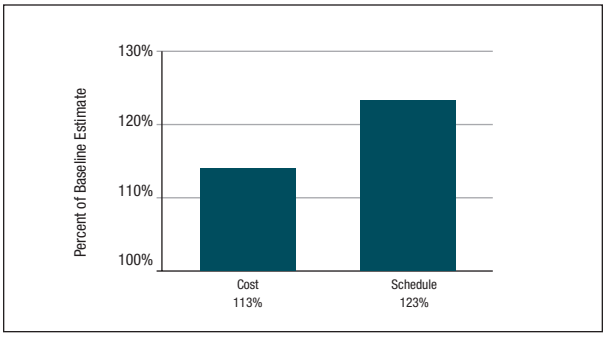
This process is the means by which NASA's Strategic Enterprises and their Centers deliver systems (ground, aeronautics, and space), technologies, data, and operational services to NASA customers. Through the use of Agency facilities, customers can conduct research, explore and develop space, and improve life on Earth. This Process is conducted by NASA's four Strategic Enterprises and their Centers and enables us to deliver products and services to customers more effectively and efficiently. In FY 2000, NASA demonstrated successful performance for four of the five objectives of the Provide Aerospace Products and Capabilities process, as supported by the targets.

Goal: Enable NASA's Strategic Enterprises and the Centers to deliver products and services to customers more effectively and efficiently while extending the technology, research, and science benefits broadly to the public and commercial sectors.

Objective: Reduce the cost and development time to deliver products and operational services.

Performance Target: Meet schedule and cost commitments by keeping the development and upgrade of major scientific facilities and capital assets within 110 percent of cost and schedule estimates, on average. **FY 2000 PAPAC #1 (0P1)**

Actual Performance: This element affects the effectiveness and efficiency with which NASA's Strategic Enterprises and Centers serve our customers. Costs for the development and upgrade of major scientific facilities and capital assets were an average of 113 percent of cost estimates. Schedules for the development and upgrade of major scientific facilities and capital assets were an average of 123 percent of schedule estimates. The cost target was exceeded by three percent and the schedule target was exceeded by 13 percent. Some schedule delays were caused by the Agency decision to conduct independent reviews of several missions near launch to ensure mission success. Other changes from baseline estimates include an increase in the requirement for the International Space Station capability from a three-person to a seven-person capability, reinsertion of the Habitation Module and related hardware and software, and structural failure of the composite hydrogen tanks on the X-33 Program. These plans will be reworked in light of the FY 2002 budget.



NASA Cost and Schedule Performance.

Target Assessment: Red; targeted performance was not achieved.

Data Source: FY 2002 300B reports that are produced by the Enterprises and submitted to the Office of the Chief Financial Officer (CFO).

Data Validation: The current projected cost and schedule is compared to the baseline estimate of cost and schedule for development and upgrade of major scientific facilities and capital assets. Data from each Enterprise is provided to the CFO for Agency roll-up.

Objective: Improve and maintain NASA's engineering capability.

Performance Target: Ensure the availability of NASA's spacecraft and ground facilities by decreasing the FY 1999 unscheduled downtime. **FY 2000 PAPAC #2 (0P2)**

Actual Performance: This element shows significant maintenance and improvement of NASA's engineering capability. In FY 1999, 5.6 percent of scheduled operating time was lost to unscheduled downtime, on average. In FY 2000, 2.8 percent of scheduled operating time was lost to unscheduled downtime, on average. The FY 2000 performance represents an improvement over the FY 1999 baseline. The Agency goal is to have less than 10 percent of scheduled operating time lost due to unscheduled downtime. All spacecraft that were in their normal mission life during FY 2000 were included in the target average. The target is written to reflect the average for the Agency. The wide-area network services are commercially purchased by NASA and are not NASA owned or operated.

Target Assessment: Blue; target was exceeded

Data Source: Spacecraft data is taken from operational logs at the respective mission operations facilities. Other major facilities data are obtained from the NASA Facility Utilization online database: *https://nrpi.hq.nasa.gov/*

Verification/Validation: The three NASA Enterprises responsible for spacecraft have established internal processes to record spacecraft unscheduled downtime data. The NASA Major Ground Facilities database collects the unscheduled downtime of ground facilities. Metrics were supplied by the NASA Centers, from which the subject spacecraft and ground facilities operation takes place.

Objective: Capture and preserve engineering and technological process knowledge to continuously improve NASA's program/project management.

Performance Target: Capture a set of "best practices/lessons learned" from each program, to include at least one from each of the four Provide Aerospace Products and Capabilities (PAPAC) subprocesses, commensurate with current program status. Data will be implemented in process improvement and program/project management training. **FY 2000 PAPAC #5 (0P5)**

Actual Performance: This element materially affects the improvement of NASA's program/project management. Over 200 lessons learned were captured for FY 2000 for 84 percent of programs. At least one lesson learned was captured for each of the four subprocesses. Lessons learned were considered during the NASA Procedures and Guidelines 7120.5B document revision for process improvement. The Program Management Council Working Group and the Training and Development Division reviewed the lessons learned and will update the training in FY 2001 as appropriate.

Target Assessment: Yellow; it is anticipated that all programs will provide lessons learned in FY 2001.

Data Source: The NASA Lessons Learned Information System (LLIS). The NASA LLIS is an online, automated database system designed to collect and make available for use the NASA lessons learned from over forty years in the aeronautics and space business: *http://llis.gsfc.nasa.gov/*

Verification/Validation: The four Enterprises ensure that at least one lesson learned or best practice per program has been captured.

Objective: Focus on integrated technology planning and development in cooperation with commercial industry and other NASA partners and customers.

Performance Target: Dedicate the percentage of the Agency's R&D budget that is established in the FY 1999

process to commercial partnerships. **FY 2000 PAPAC #6 (0P6)**

Actual Performance: The percentage of NASA's R&D budget dedicated to commercial partnerships affects integrated technology planning and development with NASA partners. In FY 1999, the Agency contributed 13.9 percent of its R&D investment to commercial partnerships. In FY 2000, NASA contributed 19 percent of its R&D investment to commercial partnerships. The FY 2000 performance represents a significant improvement over the FY 1999 performance, which exceeds the target. The National Performance Review (NPR) goal for NASA is 10–20 percent of the R&D base.

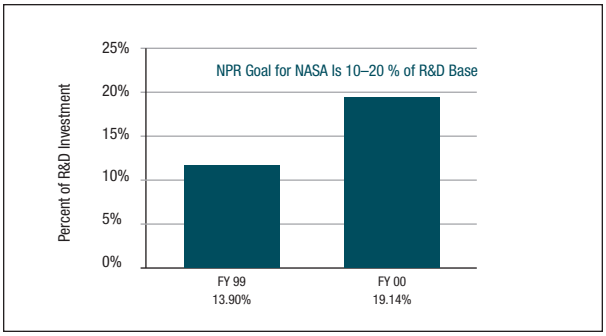
Target Assessment: Blue; target was exceeded.

Data Source: The Office of Aerospace Technology's Commercial Technology Division administers this metric's collection and reporting via NASA TechTracS—the Agencywide commercial-technology management-information system.

Verification/Validation: The Commercial Technology Division is supported by an Agencywide team called the NASA Commercial Technology Management Team, which consists of the heads of each Center's Commercial Technology Office and a representative from each Enterprise. A NASA TechTracS sub-team is led by Langley Research Center. Each Commercial Technology Office insures that appropriate and valid partnership data is entered into NASA TechTracS in a timely fashion.

Performance Target: Increase the amount of leveraging of the technology budget with activities of other organizations, relative to the FY 1999 baseline that is established during the process development. **FY 2000 PAPAC #7 (0P7)**

Actual Performance: This element significantly affects NASA's cooperation with its partners in integrating technology planning and development. The FY 1999 baseline reported that NASA invested a total of $59.5M in 55 formal joint activities with other Government agencies. In FY 2000, NASA invested a total of $141.5M in 114 formal joint activities. The FY 2000 performance represents an improvement over the FY 1999 performance.



NASA R&D Contribution to Commercial Partnerships.

Target Assessment: Green

Data Source: The data for this metric are collected as part of the Technology Inventory database that is administered by the Chief Technologist. The database is updated on an annual basis.

Verification/Validation: This metric is intended to measure NASA's investment in technology research and development with activities of other organizations. The Office of the Chief Technologist initiates the request for information from the four NASA Enterprises, who in turn coordinate the input process through their Center program managers. Program or project managers at the Field Centers provide the input data for the Inventory. The inputs are validated by at least one level of management at the Centers and subsequently by Enterprise representatives at NASA Headquarters. Following the Enterprise approval, the system administrator located at Goddard Space Flight Center merges the inputs into the final database.

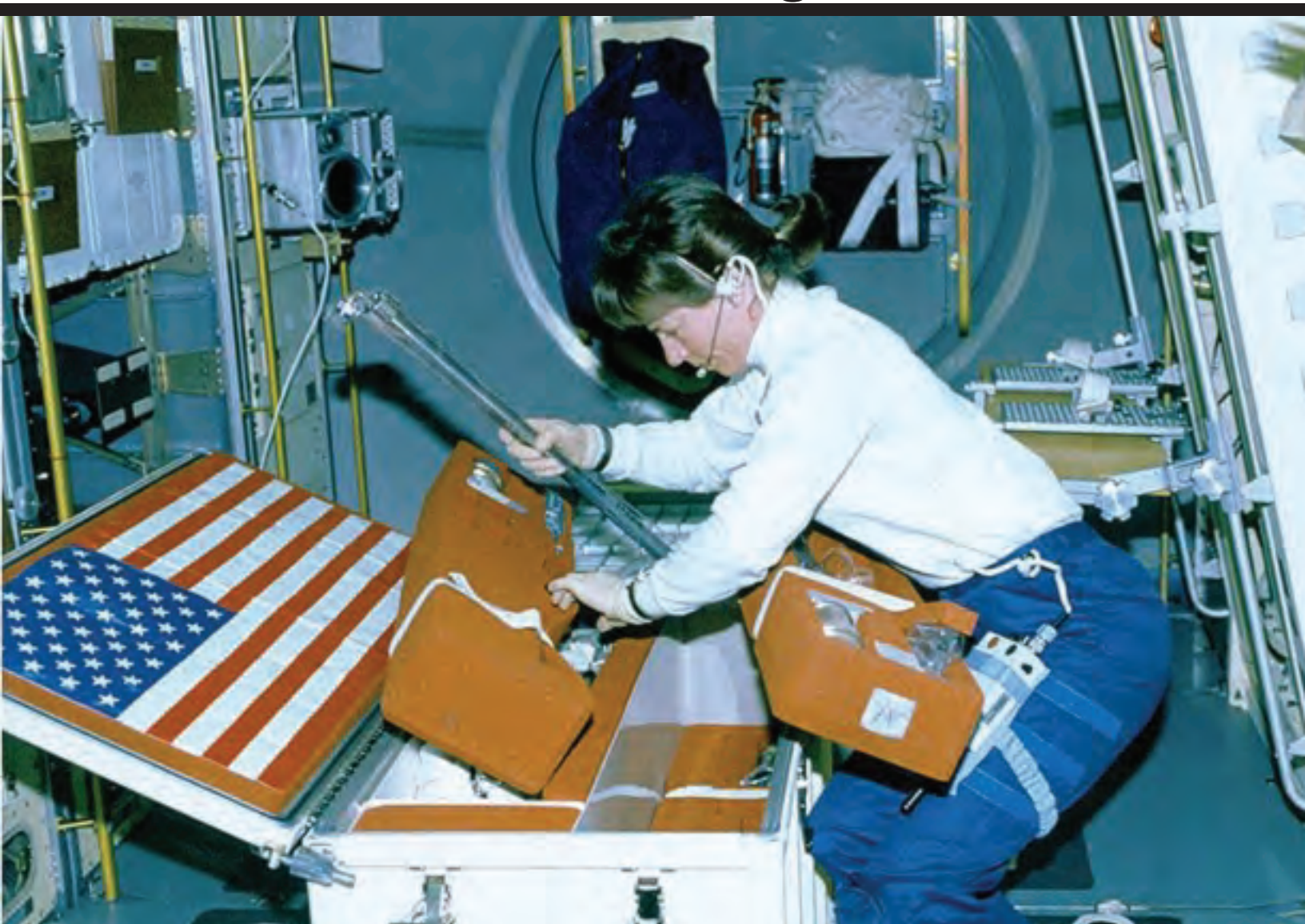
FY 2000 PROVIDE AEROSPACE PRODUCTS AND CAPABILITIES TREND DATA

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Reduce the cost and development time to deliver products and operational services.	9P1	Meet schedule and cost commitments by keeping development and upgrade of major scientific facilities and capital assets within 110% of cost and schedule estimates, on average.	Green	0P1	Meet schedule and cost commitments by keeping development and upgrade of major scientific facilities and capital assets within 110% of cost and schedule estimates, on average.	Red	Performance declined in FY 2000 as cost was exceeded by 3% and the schedule was exceeded by 13%.
Reduce the cost and development time to deliver products and operational services.	9P3	Reduce the 5-year average spacecraft cost for Space Science and Earth Science to $200M from $590M.	Yellow				Target was eliminated.
Reduce the cost and development time to deliver products and operational services.	9P4	Reduce the 5-year average spacecraft development time for Space Science and Earth Science to 5 years, 2 months from 8 years, 3 months.	Green				Target was eliminated.
Improve and maintain NASA's engineering capability.	9P2	Set up a process to determine, on average, the operating time of NASA's spacecraft and ground facilities lost to unscheduled downtime. Establish a baseline in FY 1999.	Green	0P2	Ensure the availability of NASA's spacecraft and facilities by decreasing the FY 1999 unscheduled downtime.	Blue	In FY 2000, significant progress was made in reducing unscheduled down time from 5.6% in FY 1999 to 2.8%.
Improve and maintain NASA's engineering capability.	9P8	Set up a process to improve engineering tools and skills within the Agency.	Yellow				Target was removed because it does not apply to the FY 2000 planned activities in the Agency. 0P4 is the major target for the engineering capability objective in FY 2000.
Capture and preserve engineering and technological best practices and process knowledge to continuously improve NASA's program/ project management.	9P5	Set up a process in FY 1999 to capture a set of best practices/lessons learned from each program, including at least one from each of the four PAPAC subprocesses, commensurate with current program status.	Green	0P5	Capture a set of best practices/ lessons learned from each program including at least one from each of the four PAPAC subprocesses, commensurate with current program status. Data will be implemented in PAPAC process improvement and in program/ project management training.	Yellow	Progress was made in capturing Agency best practices. 84% of NASA programs provided a total of 200 lessons learned in FY 2000. It is anticipated that lessons learned will be received from the remaining 16% of programs in FY 2000.

PROVIDE AEROSPACE PRODUCTS AND CAPABILITIES TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Focus on integrated technology planning and development in cooperation with commercial industry and other NASA partners and customers.	9P7	Set up a data collection process to determine the amount of leveraging of the R&D budget with activities of other organizations, and establish a baseline in FY 1999.	Green	0P7	Increase the amount of leveraging of the technology budget with activities of other organizations, relative to the FY 1999 baseline that is established during the process development.	Green	NASA more than doubled its investment in formal joint activities with other Government agencies in FY 2000 ($142.5M) from the FY 1999 baseline ($59.5M).
Focus on integrated technology planning and development in cooperation with commercial industry and other NASA partners and customers.	9P6	Set up a process to determine the percentage of the Agency's R&D budget dedicated to commercial partnerships and establish a baseline.	Green	0P6	Dedicate the percentage of the Agency's R&D budget that is established in the FY 1999 process to commercial partnerships.	Blue	In FY 2000, NASA increased the percentage of the Agency R&D budget that is used for commercial partnerships by 5% over FY 1999 level.

Generate Knowledge



Generate Knowledge

NASA provides new scientific and technological knowledge gained from exploring the Earth system, the solar system, and the universe and from researching biological, chemical, and physical processes in the space environment. The Generate Knowledge process ensures that this information is shared with scientists, engineers, and technologists in industry, academia, and other organizations. In addition, natural resource managers, policy makers, and educators benefit from this process. The goals of the Generate Knowledge process are to extend the boundaries of knowledge of science, technology, and engineering, to capture new knowledge in useful and transferable media, and to share new knowledge with the scientific community and the public at large.

NASA acquires advice from diverse communities to ensure that its research programs are at the forefront of the various scientific disciplines funded by the Agency. This advice is gathered by two principal methods: through the NASA Advisory Council (and the subcommittees that advise the NASA Enterprises) and through external reviews by organizations such as the National Research Council. The recommendations of these panels are used to help plan and set research priorities, which are documented in the Enterprises' Strategic Plans. These plans are updated periodically to ensure that our programs' research directions follow the latest scientific priorities. The directions outlined in the Strategic Plans in turn guide the solicitations (NASA Research Announcements and Announcements of Opportunity) and the subsequent peer review of research proposals.

The peer review process is intended to ensure that expert advice guides the selection and funding of research. In aggregate, these funded grants form the core of NASA's research programs. The results of this funded research are validated as scientifically meritorious when published in refereed journals because the journals publish what is new and remarkable. Another sign of merit is the subsequent citation of these articles by other researchers, for this is the way the scientific community signals which discoveries are both relevant and rigorous in the continuous search for knowledge.

NASA must ensure that the public and other nonscientific communities are kept abreast of the latest discoveries. This is effectively done by maintaining Web sites and data archives. Accordingly, a key element of the NASA Strategic Plan is to communicate the knowledge gained from public investments. This related process, Communicate Knowledge, promulgates the discoveries made through the Generate Knowledge process.

The Generate Knowledge process is a critical aspect of NASA's three scientific research Enterprises: the Space Science Enterprise, the Earth Science Enterprise, and the Biological and Physical Research Enterprise (formerly known as OLMSA, a part of HEDS). This process does not include research of a proprietary industrial nature or research whose conduct or dissemination is limited for reasons of national security.

The Generate Knowledge Process has eight objectives:

1. Acquire advice
2. Plan and set priorities
3. Select and fund/conduct research and analysis programs
4. Select and implement flight missions
5. Analyze data (initial)
6. Publish and disseminate results
7. Create data archives
8. Conduct further research

Objective 1: Acquire advice.

Performance Target: (Space Science, Earth Science, Life and Microgravity Science and Applications) The Space Science Enterprise (SSE), the Earth Science Enterprise (ESE), and the Office of Life and Microgravity Sciences and Applications (OLMSA) will receive at least seven formal letters of advice from their FACA-chartered advisory committees. **FY 2000 Generate Knowledge #1 (0GK1)**

Advice from external communities ensures NASA's research programs are at the forefront of the scientific disciplines funded by the Agency.

Actual Performance: Target met. ESE received two letters of advice from their advisory committees, OLMSA received three letters, and SSE received two letters.

Target Assessment: Green

Data Source: Advisory committees.

Verification/Validation: The letters are filed as official correspondence.

Objective 2: Plan and set priorities.

Performance Target (Space Science): The Space Science Enterprise will (1) complete a review of its in-place theme-based science and technology roadmaps, (2) conduct a programmatic integration meeting, and (3) prepare a revised draft Enterprise Strategic Plan for outside review. **FY 2000 Generate Knowledge #2 (0GK2)**

Actual Performance: This target ensures that the Space Science program's research directions follow the latest scientific priorities. Target met. All three items were completed during the Space Science Planning Workshops held November 2–4, 1999, in Galveston, Texas.

Target Assessment: Green

Data Source: Meeting minutes of the workshop.

Verification/Validation: The workshop minutes are part of the official record held by the Enterprise.

Performance Target (Earth Science): The Earth Science Enterprise conducts regular external assessments of the Earth Science Program content through the Biennial Review process, with the next one scheduled for 1999. In 2000, the Enterprise will review its technology, education, and commercial strategies and refine the performance metrics for these areas. **FY 2000 Generate Knowledge #9 (0GK9)**

NASA ensures that Science programs conduct research in compliance with the latest scientific priorities.

Actual Performance: Target met. ESE conducted its second Biennial Review with wide participation from Earth scientists. The results of the review were communicated in a briefing to ESE senior management in April 2000. This led to the creation of new performance metrics in each area for use in the FY 2002 Performance Plan.

Target Assessment: Green

Data Source: ESE meeting representatives.

Verification/Validation: The minutes are part of the official record of the Enterprise.

Performance Target (Life and Microgravity Science and Applications): The Life and Microgravity Science and Applications research plan, as documented in a new Strategic Plan to be published in FY 1999, will be used in FY 2000 to guide the implementation of programs and to develop future budgets. **FY 2000 Generate Knowledge #10 (0GK10)**

Actual Performance: The new Strategic Plan was not released until FY 2000. Major changes in the science program occurred, resulting in the decision to identify this research as a separate strategic element with its own Strategic Plan.

Target Assessment: Yellow, due to the late release of the new Human Exploration and Development of Space (HEDS) Strategic Plan.

Data Source: Management officials in the new Enterprise; the HEDS Strategic Plan, 2000.

Verification/Validation: HEDS Strategic Plan, 2000, available at *http://www.hq.nasa.gov/osf*

Objective 3: Select, fund, and conduct research and analysis programs.

Performance Target: (Space Science, Earth Science, Life and Microgravity Science and Applications) For selecting and funding/conducting research and analysis (R&A) and core technology projects, the Space Science Enterprise, the Earth Science Enterprise, and Life and Microgravity Science and Applications program will use broad Agency announcements (Announcement of Opportunity [AO], NASA Research Announcements [NRA], and Cooperative Agreement Notice [CAN] solicitations) to competitively award 80 percent or more of the available research resources in these programs based on peer review. **FY 2000 Generate Knowledge #3 (0GK3)**

As a matter of policy, NASA commonly uses the peer-review process to determine the predominant allocation of funds for research, and within that process, selects the most meritorious proposals.

Actual Performance: Target achieved. Earth Sciences competitively awarded 88.6 percent of the resources in these programs based on peer review. Life and Microgravity Sciences awards amounted to 80.1 percent of their science resources to peer-reviewed research. Space Science awarded 84.7 percent of its science resources to peer-reviewed research. (Note: The total budgets used as a basis for the calculation include funding required to support the peer review process, program management oversight, and related expenses.)

Target Assessment: Green

Data Source: FY 2000 Budget actuals.

Verification/Validation: These numbers are based on calculations of the actual budget. To verify, refer to the specific budgets for each of the Enterprises.

Objective 4: Select and implement flight missions.

Performance Target (Earth Science): To select flight missions, the Earth Science Enterprise will release one Earth System Science Pathfinder AO. **FY 2000 Generate Knowledge #11 (0GK11)**

	Peer reviewed research	Percentage
Space Science	$193.1M out of $227.9M	84.7%
Earth Science	$ 225M out of $253.7M	88.6%
Life and Microgravity Sciences and Applications	$220.1M out of $274.7M	80.1%
Total	$638.2M out of $756.3M	84.3%

NASA uses Announcement of Opportunity (AO) to ensure that the scientific community will be able to propose prospective flight missions in a competitive environment. The missions selected will also ensure the extension of the boundaries of scientific, technological, and engineering knowledge in an efficient and effective manner.

Actual Performance: Target met. The ESE released the AO for proposals for University Earth System Science missions in September 1999 (earlier than required date, which was the first quarter of FY 2000). (Note: This early accomplishment was not recorded for the FY 1999 Performance Report to ensure proper accounting.)

Target Assessment: Green

Data Source: NASA Peer review services.

Verification/Validation: NASA Peer Review Services Web page, *http://research.hq.nasa.gov/code_y/code_y.cfm*

Performance Target (Earth Science): To implement flight missions, the Earth Science Enterprise will successfully launch one spacecraft and deliver two instruments for international launches, within 10 percent of budget on average. **FY 2000 Generate Knowledge #13 (0GK13)**

Actual Performance: Target met. Launched Shuttle Radar Topography Mission (SRTM); Stratospheric Aerosol and Gas Experiment III (SAGE III) and JASON instruments were delivered on September 15, 1997. These were done within 7.4 percent of the budget.

Target Assessment: Green

Data Source: Earth Science Enterprise budget

Verification/Validation: The first part of this target is self explanatory, since the launch of SRTM was public news, and the delivery of the SAGE III and Jason instruments was completed. The second part may be verified by reviewing the ESE budget.

Performance Target (Space Science): To select flight missions, the Space Science Enterprise will release one Explorer-class AO and one Discovery-class AO; selections will be made for at least one AO. **FY 2000 Generate Knowledge #4 (0GK4)**

Actual Performance: Target met. AOs were released for the Discovery (released May 19, 2000) and Small Explorers (SMEX, released November 15, 1999) programs. Selections were made for concept studies for the Small Explorers on September 8, 2000.

Target Assessment: Green

Data Source: Space Science Enterprise Web site.

Verification/Validation: The Discovery and Explorer AO's are publicly available at *http://research.hq.nasa.gov/code_s/code_s.cfm* as is detailed information regarding the SMEX selections.

Performance Target (Space Science): To implement flight missions, the Space Science Enterprise will successfully launch and initiate operations for 5 Enterprise flight missions within 10 percent of budget on average. **FY 2000 Generate Knowledge #12 (0GK12)**

Actual Performance: Target partially met. Only four missions were launched in FY 2000, within 10 percent of budget on average. Successfully launched were the third mission to the Hubble Space Telescope and the Imager for Magnetopause to Aurora Global Exploration (IMAGE), plus our contributions to the European Space Agency's X-ray Multi-Mirror (XMM) mission and Cluster-2 mission; slight cost growth on two of those missions resulted in an average growth of 1.0 percent. (Note: Due to launch vehicle and range readiness delays, the NASA High Energy Transient Explorer [HETE-2], which was targeted for launch during FY 2000, was launched on October 9, 2000.)

Target Assessment: Yellow, due to the delay in the HETE-2 launch date.

Data Source: Space Science Enterprise Resources Office. Launch and operations data can also be viewed at *http://spacescience.nasa.gov/missions/opmsns.htm* Cost data is based on budget actuals.

Verification/Validation: The launch of the five missions was public news. The second part may be verified by reviewing the Space Science Enterprise budget.

Performance Target (Life and Microgravity Science and Applications): OLMSA will complete preparations for a Space Shuttle research mission that will fly in early FY 2001. **FY 2000 Generate Knowledge #14 (0GK14)**

Actual Performance: Target met. The preparations for the STS-107 mission were completed in readiness for the original target flight date. The payload complement was selected, and payload processing was scheduled to meet the original flight date. (Note: The extensive wiring checks on the Shuttle orbiters resulted in a delay in the readiness of *Columbia. Columbia* was not delivered to Kennedy Space Center until mid-FY 2001. The Hubble Space Telescope mission [3B] will be launched prior to STS-107, due to the higher cost of support for the HST servicing team.) Launch readiness plans are now targeted to meet a launch date for STS-107 in Spring 2002.

Target Assessment: Green

Data Source: Office of Life and Microgravity Sciences and Applications flight programs, manifest and mission timelines.

Verification/Validation: The target may be verified by the Space Shuttle program and the Spacehab contractor, who are responsible for the mission.

Objective 5: Analyze data (initial).

Performance Target: For the initial analysis of data, the Earth Science and Space Science Enterprises will satisfy 80 percent of their FY 2000 Enterprise performance targets in the "Operations" areas. **FY 2000 Generate Knowledge #5 (0GK5)**

After a mission is underway, return of scientific data goes through several stages of processing. The scientific investigator teams receive the scientific data after the initial stage of spacecraft performance (i.e., engineering) data processing. Getting through this stage in a timely manner and releasing the data to the science teams is of major importance.

Actual Performance: Target exceeded. For Earth Science missions, 80 percent of performance targets were met. For Space Science missions, the metric was significantly exceeded, with 90 percent met.

Target Assessment: Blue

Data Source: ESE and SSE program managers and budget analysts.

Verification/Validation: Targets may be verified by reviewing the Space Science and Earth Science performance reports.

ESE satisfied the metric by ensuring that 80 percent of on orbit science instruments are operational.

SSE satisfied 90 percent of applicable operations targets. (Note: the target for Mars Polar Lander was not met due to the mission failure; the target for Voyager was only partially met.)

Objective 6: Publish and disseminate results.

Performance Target (Space Science): For disseminating research results, the Space Science Enterprise will account for 4 percent of the 150 "most important science stories" in the annual review by *Science News*; for education and outreach, the Enterprise will meet seven of eight of its FY 2000 Enterprise Performance Plan education performance targets. **FY 2000 Generate Knowledge #6 (0GK6)**

A useful way to measure how science information generates "new knowledge" is to review the priority assigned to the release of the information by reputable magazines, such as *Science* magazine. Another is to evaluate the use of the information in educational settings.

Actual Performance: Target exceeded. The SSE was responsible for 4.9 percent of the 150 most important science stories for calendar year 1999 (the last year for which there are numbers at the time this report was generated). Seven out of the eight specific objectives detailed in the FY 2000 Enterprise Performance Plan were achieved or substantially exceeded. (The only objective not met was associated with the number of research grants having an associated education and public outreach component underway. Please refer to target number 0S67.)

Target Assessment: Green

Data Source: *Science News*, Space Science Enterprise programs.

Verification/Validation: Refer to target number 0S67 and to the *Science News* magazine end-of-year (1999) compilation of 150 most important science stories.

Performance Target (Earth Science): For disseminating research results, the Earth Science Enterprise will meet all of its FY 2000 Enterprise Performance Plan "disseminate information" performance targets; for education and outreach, the Enterprise will meet all of its FY 2000 Enterprise Performance Plan education and outreach targets. **FY 2000 Generate Knowledge #15 (0GK15)**

Actual Performance: Target met. The ESE has met or exceeded its dissemination of information performance targets. The three targets in the ESE plan are as fellows:

- Award 50 new graduate student/education research grants and 20 early career postdoctoral fellowships in Earth Science. (Target: 0Y30)
  51 Graduate Student Fellowship (GSF) grants awarded; 17 extended + NRA released for >13 early career. Data source is NASA Grants/Contracts Office.
  Target assessment: Green
- Conduct at least 300 workshops to train teachers in the use of ESE education products. (Target: 0Y31)
  340 Workshops held; data source is NASA Education Division Education Computer-aided System (EdCATS) system.
  Target assessment: Blue
- Increase the number of schools participating in GLOBE to 10,500, a 30 percent increase over FY 1999. Increase

participating countries to 77 from 72 in FY 1999. (Target: 0Y32)
9643 schools and 94 countries. Data sources are GLOBE Program Office database.
Target assessment: Yellow

Overall Targets Assessment: Green

Data Source: Earth Science Enterprise. The sources for the data are described above: NASA Grants/Contracts Office, NASA Education Division EdCATAS system, and GLOBE Program Office database.

Verification/Validation: The target may be verified by reviewing the ESE section of this report, which was developed by gathering the information provided by NASA Grants/Contracts Office, NASA Education Division EdCATAS system, and GLOBE Program Office database.

Performance Target (Life and Microgravity Science and Applications): For disseminating research results, OLMSA will publish 100 percent of its science research progress in the annual OLMSA Life Sciences and Microgravity Research Program Task Bibliographies and make the information available on the Internet. **FY 2000 Generate Knowledge #16 (0GK16)**

Actual Performance: Target met. In February 2000, 100 percent of the research tasks funded in FY 1999 were published in the Task Books. The data can be searched on the Internet at the Web site: *http://peer1.idi.usra.edu/peer_review/taskbook/taskbook.html.*

Target Assessment: Green

Data Source: Contractor report, Web site: *http://peer1.idi.usra.edu/peer_review/taskbook/taskbook.html*

Verification/Validation: The contractor publishes the Task Books after a thorough compilation and review of all the tasks that have been funded for the previous fiscal year. In other words, all the tasks funded in FY 1999 were published in February 2000. The contractor compiles the data during the first quarter of the fiscal year and publishes the document during the second quarter. The tasks include all research that received any money during that year, even if the funding was for only one month of FY 1999. Books can be viewed at *http://peer1.idi.usra.edu/peer_review/taskbook/taskbook.html*

Objective 7: Create data archives.

Creating archives of mission data ensures access to the data for interested scientists who were not part of the original mission science team. These archives also facilitate the preservation of the mission data, and ensure the greatest possible availability of the data over an extended period of time.

Performance Target (Space Science): For archiving mission data, the Space Science Enterprise will include in all Announcements of Opportunity specific directions to investigators for archiving mission data and ensure that Enterprise flight mission data are transmitted to appropriate discipline data archives no more than one year after acquisition. **FY 2000 Generate Knowledge #7 (0GK7)**

Actual Performance: Although the policy has been well established and communicated to the scientific communities involved, the specific target was not met. There were three Space Science AO's issued in FY 2000 having the following data policies:

- AO 99-OSS-05: Small Explorers (SMEX)—data are to be released as soon as possible, with specific time limits to be negotiated, based on specific mission requirements and objectives.
- AO 00-OSS-01: Space Interferometry Mission (SIM) Science Team and Key Projects—data are immediately archived by NASA and released to PI's for a proprietary period not to exceed 12 months for analysis.
- AO 00-OSS-02: Discovery—data are to be released by PI's as soon as possible, with no specific time limit given.

It is the practice of the scientists to provide the data as soon as possible, which is much earlier than one year after acquisition.

Target Assessment: Red, because the specific stipulation was not included in the AOs.

Data Source: SSE AO's

Verification/Validation: The SSE AOs are publicly available at *http://research.hq.nasa.gov/code_s/code_s.cfm*

Performance Target (Earth Science): For archiving mission data, the ESE will make available data on prediction, land surface, and climate to users within five days. The Enterprise will double the volume of data archived compared to the FY 1997 baseline (of 184 terabytes). **FY 2000 Generate Knowledge #17 (0GK17)**

Actual Performance: Target met. ESE is providing QuikSCAT data in near-real time, and other data (e.g., Landsat 7) within the five-day requirement. The volume of data was more than doubled from the FY 1997 baseline data: 500 terabytes archived, compared to 368 terabytes in target (368 = 2 times the baseline of 184 terabytes).

Target Assessment: Green

Data Source: Earth Observing System (EOS) Data Gathering and Reporting System at GSFC.

Verification/Validation: The data were gathered from the EOS Data Gathering and Reporting System at GSFC and is described in detail in the ESE performance report. Please refer to target 0Y27.

Performance Target (Life and Microgravity Science and Applications): Flight Mission Data, other than human flight mission data, will be transmitted to appropriate discipline data archives no more than 1 year after acquisition. **FY 2000 Generate Knowledge #18 (0GK18)**

Actual Performance: Performance was incomplete. This assessment is based on the experiments that flew in 1999. Only three Space Shuttle missions flew that year, and OLMSA payloads participated in one of these flights (with Chandra). Of the OLMSA small payloads aboard, four were sponsored by Gravitational Biology and Ecology (GBE), and the rest were sponsored by Space Product Development (SPD). (The SPD payloads do not archive their data because the data are proprietary.) Of the four GBE payloads, one is completed and has submitted the final report, one failed before flight (hardware failure), and the other two have requested no-cost, one year extensions of their grants with the purpose of completing the experiment analysis. These final two will submit their results next year. It must be noted that once the data are transmitted to the appropriate archive, it still takes several months of data formatting before the data are available to the general public.

Target Assessment: Red

Data Source: OLMSA program managers.

Verification/Validation: The payloads are managed at the Center level. The program managers of GBE payloads are at Ames Research Center (ARC). However, since three of the payloads are plant biology research, they are managed at the project level at Kennedy Space Center (KSC). KSC has received the final report for one of the investigators, as well as letters of request for extension of the grants of the other two investigators. These extensions were granted.

Objective 8: Conduct further research.

Performance Target (Space Science): The Space Science Enterprise will average "fully effective" across all Enterprise data analysis programs in a yearly independent retrospective productivity assessment. **FY 2000 Generate Knowledge #8 (0GK8)**

After the data from missions are collected, the greatest benefit comes from funded programs of "data analysis." These activities allow for the extraction of scientific value from the data, and result in the expansion of knowledge. This outcome represents the true return on the public's investment.

Actual Performance: Completed. The Space Science Advisory Committee (SSAC) discussed general progress against the 19 science objectives in the Space Science 1997 Enterprise Strategic Plan at its meeting during the week of October 30, 2000. The SSAC rated their status as 17 green, 1 blue, and 1 yellow. While the focus was on efforts that came to culmination last year, scientific advances usually can be traced to activities over a number of years and possibly funded additionally by non-NASA sources. "Fully Effective" is defined as "Progress fully met expectations, on average". This target refers to the use of space science data, acquired at considerable cost to the taxpayer, for scientific analysis.

Target Assessment: Green

Data Source: Space Science Advisory Committee (SSAC) minutes.

Verification/Validation: November 30, 2000 SSAC meeting minutes.

Performance Target (Earth Science): The Earth Science Enterprise will contribute in four of the six theme areas of the U.S. Global Change Research Program (USGCRP). **FY 2000 Generate Knowledge #19 (0GK19)**

Actual Performance: This element furthers the extension of the boundaries of scientific, technological, and engineering knowledge. ESE has met this target, as demonstrated by USGCRP budget crosscut for FY 2000.

NASA contributes to elements 1, 2, 3, and 6 of the following program elements of the USGCRP:

1. Understanding Earth's Climate System
2. Biology and Biogeochemistry of Ecosystems
3. Composition and Chemistry of the Atmosphere
4. Paleoenvironment/Paleoclimate
5. Human Dimensions of Global Change
6. The Global Water Cycle

Target Assessment: Green

Data Source: ESE Research Strategy and USGCRP, FY 2000 Our Changing Planet; both accessible via the ESE Home Page: *http://www.earth.nasa.gov/*

Verification/Validation: The budget crosscut for FY 2000 and the other data are documented in the report by the Subcommittee on Global Change Research, Committee on Environment and Natural Resources of the National Science and Technology Council entitled Our Changing Planet: The FY 2000 U.S. Global Change Research Program. This document is a supplement to the President's FY 2000 budget.

FY 2000 GENERATE KNOWLEDGE TREND DATA

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Select research projects through peer-reviewed and merit-based competition.	GK1	Submit 80 percent of Agency research projects to peer-reviewed processes.	Blue				Reconstituted as 0GK3, with a differently worded objective. Read assessment in 0GK3.
Provide information to the public and data to researchers.	GK2	Provide monthly updates for all missions and, where possible, on a weekly basis.	Yellow				Reconstituted as 0GK6, 0GK15, and 0GK16. This target was reconstituted to better reflect the specific needs and requirements of the different research Enterprises.
Provide information to the public and data to researchers.	GK3	Make available for researchers fully calibrated, verified, and validated science data products within 1 year of acquisition.	Yellow				Reconstituted as 0GK7, 0GK17, and 0GK18 This target was reconstituted to better reflect the specific needs and requirements of the different research Enterprises.
Acquire Advice.				0GK1	The SSE, the ESE, and OLMSA/ HEDS will receive at least seven formal letters of advice from their FACA-chartered advisory committees.	Green	FY 1999: ESE—1 letter SSE—3 letters OLMSA—3 letters FY 2000: ESE—2 letters SSE—2 letters OLMSA—3 letters
Plan and set priorities.				0GK2	The Space Science Enterprise will (1) complete a review of its in-place theme-based science and technology roadmaps, (2) conduct a programmatic integration meeting, and (3) prepare a revised draft Enterprise Plan for outside review.	Green	New target.
				0GK9	The ESE conducts regular external assessments of the Earth Science Program content through the biennial review process with the next one scheduled for 1999. In 2000, the Enterprise will review its technology, education, and commercial strategies and refine the performance metrics for these areas.	Green	New target.

GENERATE KNOWLEDGE TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Plan and set priorities (continued).				0GK10	OLMSA/HEDS will release a new Strategic Plan in FY 1999, it will be used in FY 2000 to guide the implementation of programs and to develop future budgets.	Yellow	New target.
Select, fund, and conduct research and analysis programs.				0GK3	For selecting and funding/ conducting research and analysis and core technology projects, the SSE, OLMSA, and the ESE will use broad Agency announcements (AO, NRA, and Cooperative Agreement Notice solicitations) to competitively award 80% or more of the resources in these programs based on peer review.	Green	The NASA science codes continue to consistently award 80% or more of the resources in these programs based on peer review. In FY 1999, 82% of the funds were awarded to peer reviewed investigators. In FY 2000, 84% of the funds were awarded to peer reviewed investigators.
Select and implement flight missions.				0GK11	To select flight missions, the ESE will release one Earth System Science Pathfinder AO.	Green	FY 1999: 2 AOs were issued (LightSAR and UnESS) FY 2000: 1 AO was issued (UnESS)
				0GK4	To select flight missions, the SSE will release one Explorer and one Discovery AO and make selections in response to at least one AO. (0GK4)	Green	FY 1999: 3 AOs were issued (STEREO, GLAST, and Deep Space Missions) FY 2000: 2 AOs were issued (Discovery and Small Explorers)
				0GK13	To implement flight missions, the ESE will successfully launch one spacecraft and deliver two instruments for international launches, within 10% of budget on average.	Green	FY 1999: 2 spacecraft were launched (Landsat7 and QuikSCAT) FY 2000: 1 Spacecraft was launched (SRTM)
				0GK12	To implement flight missions, the SSE will successfully launch and initiate operations for 5 Enterprise flight missions within 10% of budget on average.	Yellow	FY 1999: 7 launches FY 2000: 4 launches out of 5

GENERATE KNOWLEDGE TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Select and implement flight missions.				0GK14	OLMSA will complete preparations for a Space Shuttle research mission that will fly in early FY 2001.	Green	New target.
Analyze data (initial).				0GK5	For the analysis of data, the ESE and SSE will satisfy 80% of their FY 2000 Enterprise performance targets in the "Operations" areas.	Blue	New target.
Publish and disseminate results.				0GK6	For disseminating research results, the SSE will account for 4% of the 150 "most important science stories" in the annual review by *Science News*; for education and outreach, the Enterprise will meet 7 of 8 of its FY 2000 Enterprise Performance Plan education performance targets.	Green	FY 1999: 5% of most important science stories FY 2000: 4.9% of most important science stories
				0GK15	For disseminating research results, the ESE will meet all of its FY 2000 Enterprise Performance Plan "disseminate information" performance targets; for education and outreach, the Enterprise will meet all of its FY 2000 Enterprise Performance Plan education and outreach targets.	Green	New target.
				0GK16	For disseminating research results, OLMSA will publish 100% of its science research progress in the annual OLMSA Life Sciences and Microgravity Research Program Task Bibliographies and make the information available on the Internet.	Green	New target.
Create archives.				0GK7	For archiving mission data, the SSE will include in all AOs specific directions to investigators for archiving mission data and ensure that Enterprise flight mission data are transmitted to appropriate discipline archives no more than 1 year after acquisition.	Red	New target
				0GK17	For archiving mission data, the Earth Science Enterprise will make available data on prediction, land surface, and climate to users within 5 days. The Enterprise will double the volume of data archived compared to FY 1997.	Green	New target.

GENERATE KNOWLEDGE TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Create archives (continued).				0GK18	OLMSA will ensure that flight mission data are transmitted to appropriate discipline data archives no more than 1 year after the completion of an experiment.	Red	New target.
Conduct further research.				0GK8	The Space Science Enterprise will average "fully effective" across all Enterprise data analysis programs in a yearly independent retrospective productivity assessment.	Green	New target.
				0GK19	The Earth Science Enterprise will contribute in 4 of the 6 theme areas of the U.S. Global Change Research Program.	Green	New target.

Communicate Knowledge

Communicate Knowledge

During the past four decades, the results of NASA's scientific activities and discoveries have proven to be extremely important to the American people and to the world. NASA has a unique charter in the Space Act of 1958 to provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof. NASA uses the Communicate Knowledge process to increase understanding of science and technology, advance its broad application, and inspire achievement and innovation. The process augments the transfer of technology that is performed within the normal course of conducting research, performing missions, and executing overall the Agency's programs and projects. Communicate Knowledge is a process that ensures that the knowledge derived from the public's investment is presented and transmitted to meet the specific needs and interests of the public, educators, and NASA's constituency groups.

The goal of this process is to ensure that NASA's customers receive the information derived from NASA's research efforts that they want, in the format they want, for as long as they want it. Based on our performance in the areas of providing education, transferring technology, assisting customers in locating and using technical information, and providing a historical context for NASA's activities and achievements, we believe that the Agency has had a significant impact on communicating NASA-generated knowledge.

Industry, academia, and the public now have easier access to more relevant information than ever before. The goal was achieved through the efforts of many people and organizations, and NASA's progress toward the goal was measured by a series of performance targets that are categorized by two objectives:

1. Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to directly participate in space research and discovery.
2. Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.

Goal: Ensure that NASA's customers receive the information derived from NASA's research efforts that they want, in the format they want, for as long as they want it.

Objective: Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to participate directly in space research and discovery.

Performance Target: Assist customers who use the Scientific and Technical Information (STI) Help Desk and the NASA Image eXchange (NIX) digital image database within a specific turnaround period. **FY 2000 Communicate Knowledge #10 (0C10)**

Actual Performance: Target met. One hundred percent of the NASA inquiries were handled within the one-day requirement;

99 percent of the non-NASA inquiries were handled within the contract's three-day requirement. Actuals are 14,213 inquiries. Contractor statement of work calls for a one-day turnaround (NASA) and three days' turnaround (non-NASA).

Target Assessment: Green

Data Source: Contractor reports with spot checks to validate by NASA performance monitor for contract.

Verification/Validation: Metric data is collected by contractor as part of the contract report.

Performance Target: Support no less than 800 portable exhibit loans and send portable exhibits to a minimum of 175 targeted events per year. **FY 2000 Communicate Knowledge #11 (0C11)**

Actual Performance: NASA provided over 1500 exhibits and supported over 340 events in FY 2000. Taking NASA's message to non-traditional audiences at State fairs, conventions, and other venues brings our message to a public that may otherwise be uninformed about or uninterested in NASA programs. Seeing our message close to home or in a form not necessarily aimed at science and research makes our message more relevant to their lives. In addition, our exhibits are used for educational purposes in schools, encouraging students to study math and science.

Target Assessment: Blue

Data Source: Monthly reports from Field Centers.

Verification/Validation: Monthly reports from Field Centers include participant information so that we know how many people attended each event.

Performance Target: Seek to maintain a level of participation involvement of approximately three million with the education community, including teachers, faculty, and students. **FY 2000 Communicate Knowledge #1 (0C1)**

Actual Performance: In FY 2000, 3.4 million teachers, faculty, and students participated in NASA Education Programs. This target helps ensure that NASA customers get the information derived from NASA research efforts that they want.

Target Assessment: Blue.

Data Source: Program information collected via the NASA Education Program Framework and Evaluation System, an online data collection system fed into by Agencywide, Enterprise, and Center education programs. This system captures participant demographic information as well as excellence ratings of specific program features.

Verification/Validation: The Education Computer-aided Tracking System (EdCATS) has a multi-layered process to verify the accuracy and quality of the data collected.

1) Each program manager has access to rollup reports and to raw data, which identify the total number of records, the name of the reporter or participant, and a summary of the data. Thus, duplicate records can be identified, checked, and removed or corrected, or missing data sets can be identified and the reporter notified that they must complete their reports.

2) Each NASA-wide program manager, and Center or Enterprise point of contact, has access to a report which compiles all the records entered for their area of responsibility, so they can assess the status of their specific program records and thus work with the program managers to correct errors or provide for missing reports. These "roll up" reports also provide data at a level of detail which permits the kind of visibility that can highlight implausible numbers so that action can be taken to make corrections where needed.

3) The EDCATS program manager has access to all levels of data and checks the status of data at the program level regularly, working with Agency points of contact and/or program managers to ensure the quality of data.

4) The EDCATS software developer also checks the data and informs the EDCATS program manager of anomalies or suspected problems.

Performance Target: Increase new opportunities to transfer technology to private industry from 19,600 to 19,800. These opportunities will be made available to the public through the NASA TechTracS database and will be measured by monitoring a controlled data field that indicates the number of new technologies communicated to the public. **FY**

2000 Communicate Knowledge #9 (0C9)

Actual Performance: The target was to release 200 additional technologies to the public via NASA TechTracS. We exceeded this goal by releasing 889 additional technologies. However, the data is not available to the Public through the TechTracS database as prescribed by our targeted performance. Due to the temporary removal of items from the public NASA TechTracS database that are also available in the STI database, the total stands at 18,121. Additionally, in FY 2000 we began releasing a new type of technology data called Technology Opportunity Sheet (TOPS). In FY 2000, we released 149 TOPS.

We identified over 3,800 items in NASA TechTracS that were also STI items that also reside at Center for Aerospace Information (CASI). Over 2,000 of these were in the public version of NASA TechTracS. Rather than field information requests on these items, we have decided to modify the public NASA TechTracS as follows. There will be an archive section in NASA TechTracS where these items will be located. We are also developing automatic links that will take a user from an STI item in NASA TechTracS directly to the CASI data. We plan to have this modification to NASA TechTracS completed by the second quarter of FY 2001. Until that time, the approximately 2,000 items have been temporarily removed from the public NASA TechTracS (technically though, they are still available through CASI). Once the modification is complete, most of the 2,000 items will likely be reactivated in the public NASA TechTracS, causing the overall number of items in the public NASA TechTracS to significantly jump (actually we expect most of the 3,800 items to be included in the public NASA TechTracS). With regard to the 889 additional technologies released in FY 2000, most of these were the result of a thorough review by Langley Research Center (LaRC) of their entire technology portfolio. Of the 889 technologies released to the public in FY 2000, 642 of these were from LaRC.

Although we released 889 additional technologies in FY 2000, our overall total decreased because of the temporary removal of the STI items until we had developed an "archive" capability where these items could go. The requirement for this change to TechTracS was submitted in December of 1999. LaRC is the lead center for TechTracS.

Target Assessment: Green

Data Source: NASA TechTracS database.

Verification/Validation: Each Center's patent counsel carries out the review of new technology reports and authorization for release to the public. The actual implementation of a release is controlled when the "release to public" data field in each Centers' TechTracS is set to "yes." Access to this data field is tightly controlled by each Center.

Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.

Performance Target: The Office of Scientific and Technical Information plans to improve the NIX metasearch engine accessing all NASA digital image databases by adding QuickTime video, animation, and browse categories on NASA's key topics of interest to customers. **FY 2000 Communicate Knowledge #6 (0C6)**

Actual Performance: QuickTime video is now available via the Dryden link to NIX at *http://nix.nasa.gov* or its direct link at *http://www.dfrc.nasa.gov/gallery/photo/* Short videos and animations are available via the Langley LAVA (Langley Animation and Video Archive) link at *http://nix.nasa.gov* or its direct link at *http://lava.larc.nasa.gov* Thirty-one additional browse links have been completed and added to NIX on topics ranging from the Sun, the Moon, and each planet (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto), as well as appropriate subcategories, such as planets' moons. Changes were made to the Frequently Asked Questions to clarify information, and an additional link was added called "Additional NASA Imagery" to enable customers to access NASA imagery that was not housed in structured databases that could be searched by NIX but rather existed on NASA's Web pages.

Target Assessment: Green

Data Source: Contractor reports.

Verification/Validation: Metric data is collected by contractors as part of the contract report. Improvements are verified

by a NASA representative of the STI Program Office, Principal Center for STI Program.

Performance Target: The Office of Public Affairs is acquiring the capability to provide the media with digital, high definition video when the broadcasting industry converts to digital broadcasting in the next decade. It will also add a searchable online digital version of the NASA Headquarters photo archive to the NASA Home Page. **FY 2000 Communicate #12 (0C12)**

Actual Performance: It is important for NASA to use every available medium to get its message to the public. The public would not understand our inability to be ready to participate in high definition television (HDTV) when it becomes widely available. HDTV images are also helpful to mission managers, giving them a clearer view of hardware systems performance. NASA Television has begun implementation of its HDTV capability with Dreamtime Holdings. Marshall Space Flight Center, Kennedy Space Center, and Johnson Space Center have received their initial HDTV packages, which include cameras and VTRs. NASA will use this equipment initially to document high profile missions and to continue to build its HDTV library. NASA will provide HDTV tape to media outlets and other interested parties as requested. NASA plans to deploy HDTV packages to other Field Centers soon. We are on track with our HDTV project plan, as approved by the chief information officer in 1999. The searchable online digital version of the photo archive was completed in September 2000.

Target Assessment: Green

Data Source: NASA TV executive producer, Public Affairs representatives.

Verification/Validation: Onsite visits.

Performance Target: The Office of Public Affairs will open exhibits to new audiences. A series of new exhibits with updated information on the Agency's four Enterprises will begin circulation. New Internet sites to inform the public of exhibits available for loan will expedite the loan process and attract new audiences. Two NASA Centers will create new exhibits and renovate visitor facilities to attract and accommodate additional visitors. **FY 2000 Communicate Knowledge #13 (0C13)**

Actual Performance: New exhibits (updated in FY 1999) for the Space Science, Earth Science, Human Exploration and Development of Space, and Aerospace Technology Enterprises, were circulated to new audiences in FY 2000. Johnson Space Center and Langley Research Center now have Internet sites to inform the public of exhibits. This expedites the exhibit loan process by having information readily available on the Internet and reducing the need for correspondence and attracts new audiences by reaching a broader audience than just the local requests. Johnson Space Center and Glenn Research Center created new exhibits. Stennis Space Center and Glenn Research Center renovated their visitor facilities.

Target Assessment: Green

Data Source: Onsite visits.

Verification/Validation: In FY 2000, the NASA HQ Public Affairs, Public Services Division received data from following NASA Field Center Exhibits Offices:

ARC	21 Exhibits	8 Events
DFRC	17 Exhibits	37 Events
GRC	54 Exhibits	112 Events
JSC	1,526 Exhibits	103 Events
KSC	29 Exhibits	10 Events
LARC	178 Exhibits	71 Events
MSFC	358 Exhibits	126 Events
SSC	138 Exhibits	46 Events
TOTAL	2,621 Exhibits	513 Events

The data was included in monthly reports that, in most cases, also detailed the location of each event, the types of exhibits used at each (if requested), and the estimated number of people who walked through the exhibits area.

Performance Target: The History Office will target high school students through the use of a History Day competition on "Science, Technology, and Invention." The contest is being conducted in concert with the History Day Organization, with co-sponsored teacher workshops at every NASA Center. **FY 2000 Communicate Knowledge #14 (0C14)**

Actual Performance: The targeted performance was not achieved. During FY 2000, the theme was "Turning Points in History." This theme prompted many students to focus on space exploration for their project.

During FY 2000 the NASA History Office provided information to National History Day participants through an extensive World Wide Web page, *http://history.nasa.gov* with an average monthly hit rate of 100,000 users. The History Office also provided to NASA's Teacher Resource Centers a package of historical publications and materials that were accessed by teachers around the Nation. NASA visited six schools in the Washington, D.C. metropolitan area and met with more than 400 students in various classes. We participated in a session at the Organization of American Historians, in which more than 100 high school teachers from around the country were in attendance discussing the History Day event. We also responded to more than 11,500 requests for information from all sources; more than 3,000 of these were from students working on History Day projects. The NASA Chief Historian visited high schools during trips to Missouri, California, Florida, Michigan, Illinois, and Massachusetts, contacting more than 2,000 students. In June 2001 the NASA Chief Historian also served as a judge on the finals of National History Day at the University of Maryland, where more than 1,000 students participated.

On June 14, 2000, the History Office co-sponsored with the Education Office a spotlight on National History Day first place award winners. Seventeen middle and high school students showcased their award-winning National History Day projects, including "How Sputnik Launched the Internet" and "Mercury Program: Turning Point in U.S. Space Exploration." From over half a million students, the top 2,000 6th through 12th grade students were selected to represent their States in the 25th annual National History Day contest at the University of Maryland at College Park. These young historians brought with them the products of months of research: creative presentations in the form of dramatic performances, documentaries, exhibits, and papers. Projects cover a range of topics, including the role of robotics in space and the Hubble Space Telescope. The students exhibiting at NASA were contest winners at the State level. National History Day is a yearlong education program that brings the classroom into the community. The program mission is to promote the study of history by engaging students and teachers in the excitement of historical inquiry, community outreach, and creative presentation. National History Day also provides educational services to students and teachers, including a summer internship program, curricular materials, and Web resources, and annual teacher workshops and training institutes.

In FY 2000 we did not hold teacher workshops, as had been done in FY 1999. The reason for this was that the theme for this year's History Day competition was "Turning Points in History," and there was no emphasis on the part of the National History Day organization to conduct teacher workshops in concert with NASA.

Target Assessment: Red

Data Source: Office of Policy and Plans, History Office.

Verification/Validation: These items are verified by counters on the Web pages, reports on the numbers of information requests, monthly activity reports, e-mails, memos, letters, press releases, publications, and the NASA History Program Review which takes place each year. There is some limitation to this data in the sense that the Web page counters cannot document why an individual accesses the Web page.

Performance Target: The Office of Aerospace Technology's *Aerospace Technology Innovation* publication will be targeting medical facilities for new readership, as well as the automotive industry for new technology transfer opportunities. The organization will attend the Society for Automotive Engineers (SAE) annual trade show in Detroit, Michigan. **FY 2000 Communicate Knowledge #15 (0C15)**

Actual Performance: This element can help ensure the widest practicable and appropriate dissemination of information concerning NASA's activities and results. The Office attended the SAE trade show in FY 1999 and focused on the automotive industry that year. The Office attended the Society of Advanced Materials Processing Engineers in FY 2000 and focused in materials technologies during this year. We began this effort in FY 1999 and attended the SAE trade show because it is a good event for reaching companies across the automotive industry. We did not attend the Society for Automotive Engineers event in FY 2000 because we focused our efforts instead on working with individual

companies within the industry, such as General Motors (GM). We participated in an internal trade show that GM conducted called GM Techworld, because this was an excellent vehicle for us to reach senior decisionmakers at GM who might like to partner with NASA. The reason why we participate in these industry trade shows is that over a three to four day period we can interface with a large number of industry leaders across an entire industry sector. It is an excellent vehicle for us to communicate our technology transfer program goals. Typically, shows that we participate in range in size from 3,000 attendees to 40,000 attendees.

NASA does have a large inventory of success stories in the medical field. Aerospace Technology targeted medical facilities by distributing a special edition of *Aerospace Technology Innovation* to the medical community.

Target Assessment: Red

Data Source: Field Center Commercial Technology Offices, NASA Headquarters Aerospace Technology.

Verification/Validation: Use of Field Center "industry leads" database.

Performance Target: Provide the public with internal access to listings of (1) existing and upcoming communications events, activities, and products, and (2) best communications practices within NASA. **FY 2000 Communicate Knowledge #7 (0C7)**

Actual Performance: This element can help ensure the widest practicable and appropriate dissemination of information concerning NASA's activities and results. This process was not established as expected and the database was never developed. Listings of events, activities, and products are available on the internet. The Communicate Knowledge Working Group will address listings for best communications practices. This target was dependent on the new Communicate Knowledge process to be established across NASA in 2000 with the Centers and Headquarters submitting entries to a new online database.

Target Assessment: Red

Data Source: Office of the NASA Chief Scientist.

Verification/Validation: Listings of events, activities and products are available on the Internet. The NASA Web site (*http://www.nasa.gov/*) is updated daily and provides to the general public information about the most interesting information about the Agency. This Web site is the "hub" for the other NASA Web sites and provides links to all other areas of the agency. For example, there is a link to the Space Science Web site, (*http://spacescience.nasa.gov/*), an excellent location updated daily with the latest news, pictures of space, and education activities. In addition to links to the NASA Enterprises, the main NASA Web site also contains links to areas such as the education programs, the History Office, human resources, research opportunities, and business opportunities. The Education Programs Web site (*http://education.nasa.gov/*), for example, provides to the visitor user-friendly activity calendars, and educational products and resources. Each Field Center also offers a central Web site with numerous links to activities, events, and products specific to the area of excellence that distinguishes each Center.

Performance Target: Increase the NASA-sponsored, -funded, and/or -generated report documents for the scientific community and public from 11,600 to 13,920. **FY 2000 Communicate Knowledge #4 (0C4)**

Actual Performance: The NASA Center for Aerospace Information, on behalf of the NASA Scientific and Technical Information (STI) Program, has added 17,379 NASA documents and STI to the STI Database. This target helps ensure that NASA customers get the information derived from NASA research efforts that they want.

Total number reported as added to the collection during FY 2000, (added above the FY 1999 baseline) was 17,379 new items. NASA can independently validate the following: 15,945 in the limited and unlimited database, 1,000 from the lessons learned link via the Web, and 434 videos in the video catalog for a total of 17,379. The reason for exceeding this metric is that the contractor was asked to put priority on acquiring NASA STI and did so by (1) assigning specific people to the Centers, (2) purchasing commercial products to locate and track NASA's STI that may have bypassed the NASA organizations, and (3) getting listings of all new NASA contracts that might generate STI, and following up both internally and externally. The previous method of acquiring STI was to have the NASA Centers send the STI to the

Center for Aerospace Information (CASI). The STI Program is now more proactive in locating NASA-generated STI and adding it to the collection.

Target Assessment: Blue

Data Source: Contractor reports.

Verification/Validation: Metric data is collected by contractors as part of the contract report. Independent verification of the validity of the contractor reports is done by NASA via the entries into the STI database.

Performance Target: Increase the nontraditional NASA-sponsored STI through the NIX digital image database from 300,000 in FY 1998 to more than 470,000 in FY 2000. **FY 2000 Communicate Knowledge #16 (0C16)**

Actual Performance: For FY 2000, the NIX total is 693,038 images. This number is composed of two subsets: approximately 442,762 in databases at the Centers that link to NIX and 250,276 on NASA Web collections that are accessed by the NIX "Additional Imagery" button. The STI program took the additional proactive approach of identifying and linking to NASA Web collections of images to increase the number of items accessible through NIX.

Target Assessment: Green

Data Source: Contractor reports.

Verification/Validation: Metric data is collected by contractors as part of the contract report; reports are also received from the NASA Centers regarding their imagery additions for the year.

Performance Target: Increase the number of searched pages in NASA Web space by five percent per year, relative to 1999 baseline. **FY 2000 Communicate Knowledge #17 (0C17)**

Actual Performance: The Internet is an excellent medium through which to reach to public directly. The increase in download of our pages indicates that the public goes to NASA for information on space and that Internet use is increasing. Web page search increased from a 1999 baseline of approximately 900,000 to 984,097 for 2000—a 9.34 percent increase. Based on an actual 9.34 percent increase, the goal of 5 percent per year was surpassed.

Target Assessment: Blue

Data Source: Office of Public Affairs Webmaster.

Verification/Validation: Automatic built-in statistics gathering software.

Performance Target: Increase the capacity of the NASA Home Page to meet public demand by providing for a five percent per year increase in download capacity, using FY 1999 figures as baseline. **FY 2000 Communicate Knowledge #18 (0C18)**

Actual Performance: The Internet is an excellent medium through which to reach to public directly. The increase in download of our pages indicates that the public goes to NASA for information on space and that Internet use is increasing. In FY 2000 NASA had a 112 percent increase in Web traffic. Based on an actual 112 percent increase in the number of "hits," each of which involves a download from the server, the goal of providing for a 5 percent per year increase in download capacity was more than achieved.

Target Assessment: Blue

Data Source: Office of Public Affairs Webmaster.

Verification/Validation: Automatic built-in statistics gathering software.

Performance Target: Maintain a baseline for live satellite interview programs of no less than 10 live shots per month. **FY 2000 Communicate Knowledge #19 (0C19)**

Actual Performance: Years ago, after polling a large number of television news producers, we began producing video files and offering live news interviews rather than complete, produced programs. This allows producers to use our video as elements of the stories they put together. It is also an excellent way to communicate the results of NASA's scientific achievements and discoveries. We have exceeded our plan for the year, averaging 75 live shots per month.

Target Assessment: Blue

Data Source: NASA TV executive producer.

Verification/Validation: On-air records and reports from NASA Field Center television producers.

Performance Target: Maintain a baseline of five video file elements per week, issuing raw video and animation daily on NASA Television. **FY 2000 Communicate Knowledge #20 (0C20)**

Actual Performance: We have exceeded our plan for the year by achieving an average of 25 video file elements per week. This target helps ensure that NASA customers get the information derived from NASA research efforts that they want, in the format they want.

Target Assessment: Blue

Data Source: NASA TV executive producer.

Verification/Validation: Field Center reports and commercially acquired video monitoring report from Burrelle's.

Performance Target: Produce 12 new historical publications chronicling and placing NASA's activities and achievements in perspective for the American public. **FY 2000 Communicate Knowledge #3 (0C3)**

Actual Performance: Publications include:

1. Swanson, Glen E., editor. "*Before this Decade is Out…*" *Personal Reflections on the Apollo Program* (NASA SP-4223, October 1999).
2. Logsdon, John M., general editor. *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Volume IV, Accessing Space* (NASA SP-4407, December 1999).
3. *Aeronautics and Space Report of the President, Fiscal Year 1998 Activities* (NASA Annual Report, December 1999).
4. Dunar, Andrew J., and Stephen P. Waring, *Power to Explore: A History of the Marshall Space Flight* Center (NASA SP-4313, December 1999).
5. Maisel, Martin D., Demo J. Giulianetti, and Daniel C. Dugan. *The History of the XV-15 Tilt Rotor Research Aircraft: From Concept to Flight* (Monographs in Aerospace History #17, NASA SP-2000-4517, February 2000).
6. Rumerman, Judy A., compiler. *NASA Historical Data Book, Volume VI: NASA Space Applications, Aeronautics and Space Research and Technology, Tracking and Data Acquisition/Space Operations, Commercial Programs, and Resources, 1979–1988* (NASA SP-2000-4012, March 2000).
7. Tomayko, James E. *Computers Take Flight: A History of NASA's Pioneering Digital Fly-by-Wire Project* (NASA SP-2000-4224, April 2000).
8. Jenkins, Dennis R. *Hypersonics Before the Shuttle: A Concise History of the X-15 Research Airplane* (Monographs in Aerospace History #18, NASA SP-2000-4518, May 2000).
9. Gawdiak, Ihor Y., and Charles Shetland, compilers. *Astronautics and Aeronautics, 1991–1995: Chronology of Science, Technology, and Policy* (NASA SP-2000-4028, July 2000).
10. Chambers, Joseph R. *Partners in Freedom: Contributions of the Langley Research Center to U.S. Military Aircraft in the 1990s* (Monographs in Aerospace History #19, NASA SP-2000-4519, September 2000).
11. Siddiqi, Asif A. *Challenge to Apollo: The Soviet Union and the Space Race, 1945-1974* (NASA SP-2000-4408, September 2000).
12. Bugos, Glenn E. *Atmosphere of Freedom: Sixty Years at NASA Ames Research Center* (NASA SP-2000-4314, September 2000).

Target Assessment: Green

Data Source: NASA History Office.

Verification/Validation: Measurement is based on actual count of publications.

Performance Target: Provide publications that will communicate technologies available for commercial use and technologies that have been commercialized by industry to facilitate technology transfer. The three principal publications are *Aerospace Technology Innovation*, *Spinoff*, and *Tech Briefs*, whose effectiveness will be measured by monitoring readership and frequency of use as sources of reference. **FY 2000 Communicate Knowledge #21 (0C21)**

Actual Performance: All publications were developed, printed, and distributed on production schedule. Readership, as measured by the hits online:

Aerospace Technology Innovation: 249,200 online hits (e.g., electronic readership) for FY 2000.
Spinoff: 985,000 online hits (e.g., electronic readership) for FY 2000.
Tech Briefs: 750,000 online hits (e.g., electronic readership) for FY 2000.

In addition to the online distribution, paper copies are published as follows:

Aerospace Technology Innovation: 13,000 copies bi-monthly.
Spinoff: 150,000 copies annually.
Tech Briefs: 200,000 copies monthly.

Target Assessment: Green

Data Source: Field Center Commercial Technology Offices and industry partners.

Verification/Validation: *Aerospace Technology Innovation* mailing list and electronic subscription request file, recorded inventory and distribution request, and monitored Web site "hits."

Performance Target: Publish at least one industry-specific *Aerospace Technology Innovation* issue per year. **FY 2000 Communicate Knowledge #22 (0C22)**

Actual Performance: Published a special edition on NASA medical and material technologies in October 1999 and May 2000.

Special editions of the *Aerospace Technology Innovation* publication were published to promote NASA medical and material technologies to targeted industry groups. These technologies were identified as key areas were NASA could serve industry needs. The *Aerospace Technology Innovation* publication will be targeting medical and material entities for new readership.

Target Assessment: Blue

Data Source: "NASA Announces Materials Sector Initiative" (March/April 2000) and "NASA Contributes to the Medical Field" (Sept/Oct 1999) issues of *Aerospace Technology Innovation*. Field Center Commercial Technology Offices, NASA Headquarters.

Verification/Validation: *Aerospace Technology Innovation* mailing list, recorded inventory and distribution request, and monitored Web site "hits."

FY 2000 COMMUNICATE KNOWLEDGE TREND DATA

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to participate directly in space research and discovery.				0C10	Assist customers who use the STI Help Desk and the NIX digital image database within a specific turnaround period.	Green	Emphasis on customer service.
Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to participate directly in space research and discovery.				0C11	Support no less than 800 portable exhibit loans and send portable exhibits to a minimum of 175 targeted events per year.	Blue	Increased public awareness by providing over 1,500 exhibits and supporting over 340 events in FY 2000.
Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to participate directly in space research and discovery.	CK1	Increase the number of educators who participate annually in NEWEST/NEWMAST (the programs have been combined and are being called NEW-NASA's Education Workshops) to 500 from 400 in FY 1998.	Green				Target was eliminated.
Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to participate directly in space research and discovery.	CK2	Increase the number of students reached through NEWEST/NEWMAST (NEW) program to 42,000 students from 33,600 in FY 1998.	Green				Target was eliminated.
Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to participate directly in space research and discovery.	CK3	Maintain the participation level in Agencywide educational programs at more than 1 million teachers and students.	Blue	0C1	Seek to maintain a level of participation involvement of approximately 3 million with the education community, including teachers, faculty, and students.	Blue	The FY 2000 target was refined to better reflect FY 1999 baseline data. Participation in FY 2000 was strong (exceeded targeted performance), though less than in FY 1999.

COMMUNICATE KNOWLEDGE FY 2000 TREND DATA (continued)

FY 1999 Objective	FY 1999 99#	Target	FY 2000 Rating	FY 2000 00#	Trend Target	Rating	Assessment
Highlight existing and identify new opportunities for NASA's customers, including the public, the academic community, and the Nation's students, to participate directly in space research and discovery.	CK12	Increase new technology opportunities from 19,600 to 19,700. These will be made available to the public through the NASA TechTracS database and will be measured by monitoring a controlled data field that indicates the number of new technologies communicated to the public.	Blue	0C9	Increase new opportunities to transfer technology to private industry from 19,600 to 19,800. These opportunities will be made available to the public through the NASA TechTracS database and will be measured by monitoring a controlled data field that indicates the number of new technologies communicated to the public.	Green	The goal in FY 2000 to release 200 additional technologies to the public was exceeded as 889 technologies were released, continuing the increase of technology transfers to private industry.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C6	STI plans to improve NIX metasearch engine accessing all NASA digital image databases, adding Quick-Time video, animation, and browse categories on NASA's key topics of interest to customers.	Green	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C12	The Office of Public Affairs is acquiring the capability to provide the media with digital, high-definition video when the broadcasting industry converts to digital broadcasting in the next decade. It will also add a searchable online digital version of the NASA Headquarters photo archive to the NASA Home Page.	Green	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C13	The Office of Public Affairs will open exhibits to new audiences. A series of new exhibits with updated information on the Agency's four Enterprises will begin circulation. New Internet sites to inform the public of exhibits available for loan will expedite the loan process and attract new audiences. Two NASA Centers will create new exhibits and renovate visitor facilities to attract and accommodate additional visitors.	Green	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C14	The History Office will target high school students through the use of a History Day competition on "Science, Technology, and Invention." The contest is being conducted in concert with the History Day Organization, with co-sponsored teacher workshops at every NASA Center.	Red	New target.

COMMUNICATE KNOWLEDGE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C15	The Office of Aerospace Technology's *Aerospace Technology Innovation* publication will be targeting medical facilities for new readership, as well as the automotive industry for new technology transfer opportunities. The organization will attend the SAE annual tradeshow in Detroit, Michigan.	Red	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C7	Provide the public with internal access to listings of (1) existing and upcoming communications events, activities, and products, and (2) best communications practices within NASA.	Red	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C4	Increase the NASA-sponsored, funded, or generated report documents for the scientific community and public from 11,600 to 13,920.	Blue	New target.
Improve the external constituent communities' knowledge, understanding,and use of the results and opportunities associated with NASA's programs.				0C16	Increase the nontraditional NASA-sponsored scientific and technical information through the NIX digital image database from 300,000 in FY 1998 to more than 470,000 in FY 2000.	Green	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C17	Increase the number of searched pages in NASA Web space by 5% per year, relative to the 1999 baseline.	Blue	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C18	Increase the capacity of the NASA Home Page to meet public demand by providing for a 5% per year increase in download capacity, using FY 1999 figures as baseline.	Blue	New target.

COMMUNICATE KNOWLEDGE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C19	Maintain a baseline for live satellite interview programs of no less than 10 live shots per month.	Blue	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C20	Maintain a baseline of 5 video file elements per week, issuing raw video and animation daily on NASA television.	Blue	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.	CK9	Produce 10 new publications chronicling and placing NASA's activities and achievements in perspective for the American public. Sponsor or co-sponsor one major scholarly conference.	Blue	0C3	Produce 12 new historical publications chronicling and placing NASA's activities and achievements in perspective for the American public.	Green	Targeted goal of producing 12 new historical publications was achieved representing a 20% increase in publications from FY 1999.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C21	Provide publications that will communicate technologies available for commercial use and technologies that have been commercialized by industry to facilitate technology transfer. The three principal publications are *Aerospace Technology Innovation*, *Spinoff*, and *Tech Briefs*, whose effectiveness will be measured by monitoring readership and frequency of use as sources of reference.	Green	New target.
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.				0C22	Publish at least one industry-specific *Aerospace Technology Innovation* issue per year.	Blue	New target.

COMMUNICATE KNOWLEDGE FY 2000 TREND DATA (continued)

Objective	99#	FY 1999 Target	FY 1999 Rating	00#	FY 2000 Target	FY 2000 Rating	Trend Assessment
Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA's programs.	CK10	Acquire 10,550 NASA-sponsored, -funded, and/or -generated report documents for the American scientific community and public, publish 26 issues of an electronic current awareness product to announce additions to the NASA STI database, and add 24,400 bibliographic/ citation records to the online NASA STI database describing scientific and technical publications available to the American public.	Blue				Target was eliminated.

Acronyms and Abbreviations

Acronyms and Abbreviations

A

AACS	Articulation and Attitude Control Subsystem
AAS	American Astronomical Society
ACE	Advanced Composition Explorer
ACRIM	Active Cavity Radiometer Irradiance Monitor
ACS	Advance Camera for Surveys
ACTS	Advanced Communications Technology Satellite
ADEOS	Advanced Earth Observation Satellite
ADP	Automated Data Processing
ADTT	Advancd Design Technology Test Bed
aFAST	Active Final Approach Spacing Tool
AGU	American Geophysical Union
AHMS	Advanced Health Management System
AILS	Airborne Information for Lateral Spacing
AISRP	Applied Information Systems Research Program
ALI	Advanced Land Imager
ALR	Audit Liaison Representative
AMS	American Meteorological Society
AMTEC	Alkali Metal Thermoelectric Converter
AO	Announcement of Opportunity
APL	Applied Physics Lab
ARC	Ames Research Center
ARPS	Advanced Radioactive Power Source
ASAP	Aerospace Safety Advisory Panel
ASI	Agency Safety Initiative
ASM	All-Sky Monitor
AST	Advanced Subsonic Technology
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATE	Aerospace Technology Enterprise
AVHRR	Advanced Very High Resolution Radiometer
AVOSS	Aircraft Vortex Spacing System
AXAF	Advanced X-ray Astrophysics Facility (former acronym for Chandra)

B

BATSE	Burst and Transient Source Experiment
BLSA	Baltimore Longitudinal Study of Aging
BMS	Bristol-Myers Squibb
BOOMERANG	Balloon Observations of Millimetric Extragalactic Radiation
BPRE	Biological and Physical Research Enterprise
BTEM	Beam Test of Engineering Model

C

CAMMP	Center for Advanced Microgravity Materials Processing
CAN	Cooperative Agreement Notice
CAPPS	Consolidated Agency Personnel and Payroll System
CASI	Center for Aerospace Information
CAU	Cockpit Avionics Upgrade
CCACS	Center for Commercial Applications of Combustion in Space
CDR	Critical Design Review
CFO	Chief Financial Officer
CFS	Core Financial System
CGCM	Coupled General Circulation Models
CGRO	Compton Gamma Ray Observatory
CHeCS	Crew Health Care System
CLARA	Center for Local and Regional Applications
CK	Communicate Knowledge
CME	Coronal Mass Ejection
CNES	Centre National d'Etudes Spatiales (National Center for Space Studies, France)
CNMOS	Consolidated Network Mission Operations Support
CO	carbon monoxide
CO_2	carbon dioxide
COBE	Cosmic Background Explorer
COMPTEL	Compton Telescope
CPU	Central Processing Unit
CRSP	Commercial Remote Sensing Program
CRV	Crew Return Vehicle
CSA	Canadian Space Agency
CSC	Commercial Space Center
CSOC	Consolidated Space Operations Contract

CSRS	Civil Service Retirement System
CTAS	Center TRACON Automation System
CXO	Chandra X-ray Observatory

D

DAAC	Distributed Active Archive Center
dB	decibel
DCAA	Defense Contract Audit Agency
DCATT	Developmental Cryogenic Active Telescope Testbed
DCMC	Defense Contract Management Command
DFRC	Dryden Flight Research Center
DIAL	Data Information and Access Link
DISA	Defense Information Systems Agency
DOD	Department of Defense
DOL	Department of Labor
DRL-DFD	(German Aerospace Center—Remote-Sensing Data Center)
DS	Deep Space

E

EAA	Experimental Aircraft Association
EAPU	Electric Auxiliary Power Unit
ECR	Early Career Research
ECS	EOSDIS Core System
EM	engineering model
EOCAP	Earth Observations Commercial Applications Program
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EOSISI	EOS Interdisciplinary Science Investigation
E/PO	Education and Public Outreach
ERAST	Experimental Research Aircraft Sensor Technology
ER	EXPRESS Racks
ESE	Earth Science Enterprise
ESIP	Earth Science Information Partner
ESSAAC	Earth System Science and Applications Advisory Committee
ETM+	Enhanced Thematic Mapper
EUVE	Extreme Ultraviolet Explorer
EVA	Extravehicular Activity

F

FAA	Federal Aviation Administration
FACS	Financial and Contractual Status
FAR	Federal Acquisition Regulation
FECA	Federal Employees Compensation Act
FEHB	Federal Employee Health Benefit
FEMA	Federal Emergency Management Agency
FMS	Flight Management System
FIRST	Far Infrared and Submillimeter Telescope
FTE	Full-time equivalent
FTS	Flight Termination Systems
FUSE	Far Ultraviolet Spectroscopic Explorer
FY	Fiscal year

G

GACP	Global Aerosol Climatology Project
GALEX	Galaxy Evolution Explorer
GAC	Global Air Coverage
GAO	General Accounting Office
GAP	General Aviation Propulsion
GBE	Gravitational Biology and Ecology
GISS	Goddard Institute for Space Studies
GK	Generate Knowledge
GISS	Goddard Institute for Space Studies
GLAS	Geoscience Laser Altimeter System
GLAST	Gamma Ray Large Space Telescope
GLOBE	Global Learning Observations for a Better Environment
GOES	Geostationary Operational Environmental Satellite
GODAE	Global Ocean Data Assimilation Experiment
GPMC	Goddard Program Management Council
GPRA	Government Performance and Results Act
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment
GRC	Glenn Research Center
GRS	Gamma Ray Spectrometer
GSFC	Goddard Space Flight Center
GTE	General Technology Electric

H

HBCU	Historically Black Colleges and Universities
HDF	Hierarchical Data Format
HDTV	High Definition Television
HEASARC	High Energy Astrophysics Science Archive Research Center
HEDS	Human Exploration and Development of Space
HESSI	High Energy Solar Spectrographic Imager
HETE	High Energy Transient Explorer
HEXTE	High Energy X-ray Timing Experiment
HP	Hewlett-Packard
HRF	Human Research Facility
HST	Hubble Space Telescope
HTCI	HEDS Technology/Commercialization Initiative

I

ICAO	International Civil Aviation Organization
ICC	Integrated Cargo Carrier
ICEsat	Ice, Clouds, and Land Elevation Satellite
IERS	International Earth Rotation Service
IFA	In-flight Anomoly
IFMP	Integrated Financial Management Program
IFMS	Integrated Financial Management System
IFSR	Interferometric Synthetic Aperture Radar
IG	Inspector General
IIP	Instrument Incubator Program
IMAGE	Imager for Magnetopause-to-aurora Global Exploration
IMP	Interplanetary Monitoring Platform
INPE	(National Institute of Space Research, Brazil)
INTEGRAL	International Gamma Ray Astrophysics Laboratory
IPCC	Intergovernmental Panel on Climate Change
IPG	Information Power Grid
IRAC	Infrared Array Camera
IRIS	Incident Reporting Information System
IRS	Infrared Spectrograph
ISAS	Institute for Space and Astronautical Science
ISDC	INTEGRAL Science Data Center
ISO	International Standards Organization
ISS	International Space Station
ISTP	International Solar-terrestrial Physics Program
IT	Information Technology
ITEA	International Technology Education Association

J

JGR	*Journal of Geophysical Research*
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center

K

KSC	Kennedy Space Center

L

LAC	Land Air Coverage
LaRC	Langley Research Center
LAVA	Langley Animation and Video Archive
LED	Light-emitting Diode
LH_2	liquid hydrogen
LLIS	Lessons Learned Information System
LMSAAC	Life and Microgravity Sciences and Applications Advisory Committee

M

MACS	Massive Cluster Survey
MAP	Microwave Anisotropy Mission
MAXIMA	Millimeter Anisotropy Experiment Imaging Array
MCO	Mars Climate Orbiter
MEDS	Multifunctional Electronic Display Subsystem
MEIT	Multi-element Integration Testing
MEP	Mars Exploration Program
MGS	Mars Global Surveyor
MICAS	Miniature Integrated Camera Spectrometer
MIP	Mars In Situ Propellant Production Precursor

MIPS	Multiband Imaging Photometer; Million Instructions Per Second
MOC	Mars Orbiter Camera
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MPL	Mars Polar Lander
MPLM	Multi-purpose Logistics Modules
MSFC	Marshall Space Flight Center
MSG	Microgravity Science Glovebox
MSR	Monthly Status Review

N

NAC	NASA Advisory Council
NACC	NASA Automated Data Processing Consolidation Center
NASA	National Aeronautics and Space Administration
NASIRC	NASA Automated Systems Incident Response Capability
NEAR	Near Earth Asteroid Rendezvous
NEPA	National Environmental Policy Act
NESDIS	National Environmental Satellite, Data, and Information Service
NGST	Next Generation Space Telescope
NIAT	NASA Integrated Action Team
NIH	National Institutes of Health
NISN	NASA Integrated Services Network
NIX	NASA Image eXchange
NMO	NASA Management Office
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxide
NPD	NASA Policy Directive
NPG	NASA Procedures and Guidelines
NPPS	NASA Personnel Payroll System
NPR	National Performance Review
NRA	NASA Research Announcement
NRC	Nuclear Regulatory Commission
NSA	National Security Agency
NSBRI	National Space Biomedical Research Institute
NSIPP	NASA Seasonal to Interannual Prediction Program
NSTAR	NASA Solar Propulsion Technology Applications Readiness
NSTA	National Science Teachers Association
NSTC	National Science Technology Council

O

OAT	Office of Aerospace Technology
OCTS	Ocean Color Temperature Sensor
ODIN	Outsourcing Desktop Initiative for NASA
OIG	Office of Inspector General
OLMSA	Office of Life and Microgravity Science Applications
OMB	Office of Management and Budget
OMS	Office of Management Systems
OSSE	Oriented Scintillation Spectrometer Experiment

P

PAPAC	Provide Aerospace Products and Capabilities
PBC	Performance-based Contract
PCA	Proportional Counter Array
PCU	Proportional Counter Unit
PDR	Preliminary Design Review
PEM	Production Efficiency Model
PI	Principal Investigator
PMC	Program Management Council
POLDER	Polarization and Directionality of Earth's Reflectance
PP&E	Property, Plant, and Equipment
PSU	Practical Salinity Units
Pub.L	public law

R

R&A	Research and Analysis
R&D	Research and Development
RCC	Range Commanders Council
RESAC	Regional Earth Science Applications Center
RMS	Remote Manipulator System
ROSAT	Roentgen Satellite
RPA	Remotely Piloted Aircraft
RSI	Required Supplementary Information
RSSI	Required Supplementary Stewardship Information
RXTE	Rossi X-Ray Timing Explorer

S

SAE	Society for Automotive Engineers
SAFARI	South African Fire Atmospheric Research Initiative
SAGE	Stratospheric Aerosol and Gases Experiment
SAMPEX	Solar, Anomalous, and Magnetospheric Particle Explorer
SAP	Systems, Applications, and Products in Data Processing
SAR	Synthetic Aperture Radar
SBIR	Small Business Innovation Research
SCIGN	Southern California Integrated GPS Network
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SEBAL	Surface Energy Balance Algorithm for Land
SHADOZ	Southern Hemisphere Additional Ozone
SIRTF	Space Infrared Telescope Facility
SIM	Space Interfermometry Mission
SIMBIOS	Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies
SIS	Superconductor-Insulator-Superconductor
SLD	Supercooled Large Droplets
SLI	Space Launch Initiative
SM	Servicing Mission
SMEX	Small Explorer
SOFIA	Stratospheric Observatory for Infrared Astronomy
SOHO	Solar and Heliospheric Observatory
SOLVE	SAGE III Ozone Loss and Validation Experiment
SOMO	Space Operations Management Office
SPD	Space Product Development
SPI	Spectrometer INTEGRAL
SRTM	Shuttle Radar Topography Mission
SSAC	Space Science Advisory Committee
SSC	Stennis Space Center
SSE	Space Science Enterprise
SFFAS	Statement of Federal Financial Accounting Standards
SSFL	Santa Susana Field Laboratory
SSIWG	Salinity and Sea Ice Working Group
SSME	Space Shuttle Main Engine
SSRMS	Space Station Remote Manipulator System
STB	System Test Bed
STEREO	Solar Terrestrial Relations Observatory
S-TDC	Stirling Technology Demonstration Converter
STI	Scientific and Technical Information
STS	Space Transportation System
STScI	Space Telescope Science Institute
SWG	Science Working Group

T

TB	Terabyte
TCU	Tribal Colleges and Universities
TDRS	Tracking and Data Relay Satellite
THESEO	Third European Stratospheric Experiment on Ozone
TIMED	Thermosphere=Ionosphere=Mesosphere Energetics and Dynamics
TMI	Terra Metrics, Inc.
TOMS	Total Ozone Mapping Spectrometer
TOMS-EP	Total Ozone Mapping Spectrometer Earth Probe
TOPEX	Ocean Topography Experiment
TOPS	Technology Opportunity Sheet
TPF	Terrestrial Planet Finder
TRACE	Transition Region and Coronal Explorer
TRACON	Terminal Radar Approach Control
TRL	Technology Readiness Level
TRMM	Tropical Rainfall Measuring Mission
TWINS	Two Wide-angle Imaging Neutral-atom Spectrometers

U

UNEX	University Explorer
USA	United Space Alliance
USC	United States Code
USGS	United States Geological Survey

V

V&V	Verification and Validation

W

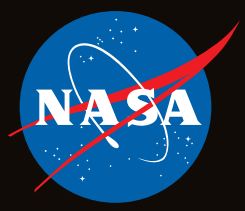
WCT	Wavefront Control Test Beds

"Never give up,

never give up,

never **ever** give up."

—Winston Churchill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